Environmental Guidelines for Dairy Producers

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Environmental Guidelines for Dairy Producers

Preface

The Dairy Industry and the Environment

Agricultural production in British Columbia is very diverse. However, a common need for all agriculture is to use and sustain the land and water resource for crop and animal production. The long term existence of the agricultural industry is dependent upon protecting this resource base, requiring farmers and ranchers to use environmentally sound agricultural practices. Farming practices need to be reviewed to ensure that everyday farm management is in harmony with the environment. Some farm practices that have been used for many years, when evaluated today, may need to be changed.

Major management concerns in the B.C. dairy industry include the handling and use of dairy cattle manure in the environment, the disposal of milkhouse wastes and silage effluent.

Although dairy cattle manure is a valuable source of nutrients and organic matter for plant production, incorrectly managed these same valuable nutrients can harm the environment. Most dairy producers recognize the need to manage their operation in an environmentally responsible manner.

It is with a strong awareness of the sensitivity of the environment that these guidelines have been written. They are intended to ensure that not only a sustainable environment for agricultural production continues, but also a safe environment for others is achieved.

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Environmental Guidelines for Dairy Producers

1: Introduction

The dairy industry uses the land and water resource under intensive production systems. This intensive use and the sensitivity of the environment makes operating in an environmentally sustainable manner a significant challenge.

Federal and Provincial laws exist to protect the environment from contaminants from many sources, including agriculture. For example, the Provincial Code of Agricultural Practice for Waste Management contains standards for environmentally sound agricultural practices.

The purpose of these guidelines is to describe management options that are environmentally sound, and which comply with existing Federal and Provincial environmental laws. These guidelines describe *generally acceptable farming practices* and apply to all dairy producers in BC. However, due to local differences, not all portions of the guidelines need apply to every producer. To prevent pollution from occurring, producers may need management options not found in these guidelines. The individual producer must find, and put into use, these other options to prevent pollution. A professional qualified in environmental assessment should review these options before use.

The BC Federation of Agriculture and its member organizations co-operated in the development of this publication. Information in this publication is based on the best available research data and years of experience.

1.1: Use of the Guidelines

People trained or with experience in dairy cattle production can use these guidelines to evaluate current dairy cattle management practices. Producers should adopt changes, if necessary, to protect the environment.

Individuals not knowledgeable in dairy farming should not

extract portions of this publication, nor draw inference, without considering all aspects of the problem.

Governments are encouraged to use these guidelines when dealing with environmental issues affecting the dairy industry. However, governments should not adopt any part of these guidelines literally into legislation. Remember, not all portions of the guidelines need apply to every producer.

Dairy producers are subject to nuisance complaints from neighbours. These complaints could be unjustified where producers are following generally accepted farming practices. These guidelines can be used when assessing nuisance issues. To protect producers from such complaints, the Province enacted the Agriculture Protection Act.

Some terms not defined in the text are explained in the Glossary of Terms (Appendix F).

To aid in future revisions, your comments on this publication are requested. An evaluation form is attached on the last page for your suggestions or comments.

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Environmental Guidelines for Dairy Producers

2: Legislation

This section deals with Local, Provincial and Federal government environmental legislative requirements affecting dairy producers. Each level of government has legislative requirements to prevent pollution or nuisance. Compliance with one agency does not necessarily mean that those requirements satisfy all agencies. Non-compliance with the legislative requirement of an agency can be serious. For example, BC Ministry of Environment, Lands and Parks could require a producer to get a permit to continue to operate.

There are several non-regulatory programs that support producers in meeting the various legislative requirements. These programs encourage the implementation of farm practices that protect the environment. Programs under the BC Ministry of Agriculture and Food are explained in Appendix A. Ministry programs include: Best Agricultural Waste Management Plan, Best Soil Management Plan, Agricultural Land Development Assistance and The Nitrogen Behaviour Simulation Computer Model. The BC Federation of Agriculture, Agricultural Environmental Protection Council, and Land Management Assistance Program are explained in Appendix B.

2.1: Local Government

Local governments can enact and enforce a variety of land use plans and zoning by-laws. A zoning by-law can identify particular areas for agriculture use within a region or district. Zoning by-laws can also establish specific setbacks for the siting of farm buildings. Local governments use specific setback distances from lot lines to help reduce conflicts between neighbours. Setbacks from watercourses are intended to reduce pollution.

The Municipal Act gives local governments authority to establish legislation. However, legislation within the Agricultural Land Reserve is subject to review by the Agricultural Land Commission.

Existing dairy operations not in compliance with a new by-law are non-conforming. This means local government may allow the operation to continue but be limited to the existing size. Expansion is permitted if the full operation meets the requirements of the new by-law.

The number of by-laws that affect agriculture varies with each local government. Local government legislation can regulate:

- specific areas within a Region or Municipality where dairy cattle production is permitted;
- specific setback distances from lot lines for farm buildings;
- building requirements in flood plains;
- nuisance, e.g., excessive noise from farm machinery; and
- setback distances from farm facilities to watercourses.

2.2 Provincial Government

Five Provincial Government Ministries in British Columbia administer Acts that impact farm practice. When Provincial and Federal Acts or regulations change, producers must meet the changes. This is because there is no non-conforming status as in local government legislation.

MINISTRY OF MUNICIPAL AFFAIRS, RECREATION AND CULTURE

Municipal Act. This Act gives local governments the authority to write by-laws that control the use and development of land. Community plans, land use by-laws, and development permits are methods used to control land use. The Municipal Act also gives local government the authority to make by-laws that control nuisance.

MINISTRY OF HEALTH

Health Act. This Act regulates farm practices that may be a health hazard. A health hazard exists when nutrients or pathogens cause a health problem. Sanitary regulations address slaughtering facilities, dead animal disposal and in-barn washroom facilities.

MINISTRY OF ENVIRONMENT, LANDS AND PARKS

Waste Management Act. This provincial legislation is responsible for controlling pollution from the agricultural industry.

This Act defines pollution as "the presence in the environment of substances or contaminants that substantially alter or impair the

usefulness of the environment."

The Province has enacted an ***Agricultural Waste Control Regulation***, and a ***Code of Agricultural Practice for Waste Management***. A copy of the complete Regulation and Code is in Appendix C.

Producers who conform to the Code are exempt from holding a Waste Management permit. This does not imply that a dairy producer is exempt from the rest of the Act. A producer must obtain a Waste Management Permit to use non-agricultural wastes. Agricultural wastes not handled in compliance with the Code also require a Waste Management Permit.

The Waste Management Act contains a regulation that applies to the management of *Special Wastes*. Waste oil and pesticide containers are considered special wastes.

Pesticide Control Act. This act applies to the sale, transportation, storage, preparation, application and disposal of pesticides. The Act requires Pesticide Use Permits for use on public land as well as on private land used for forestry, transportation or public utilities.

MINISTRY OF AGRICULTURE AND FOOD

Agriculture Protection Act. This act protects dairy producers from the threat of unwarranted nuisancesuits. Protection against such suits depends upon reasonable operation in accordance with generally accepted farm practices. Protection also requires that the operation comply with other relevant local, provincial and federal legislation related to the farm practice being challenged in the nuisance suit. Only dairy operations within the Agricultural Land Reserve qualify for protection under the Act.

Milk Industry Act. The dairy program of the BC Ministry of Agriculture and Food is the administrative body for the Milk Industry Act. The regulations enforced under this Act deal with waste management practices that directly affect the sanitary production of milk, including the location and management of milking and housing facilities.

MINISTRY OF TRANSPORTATION AND HIGHWAYS

Highways Act. Any noxious, or filthy substance, or dead animals left on a road right of way is unlawful under this Act.

Dirt or manure left on the road can be a source of pollution or nuisance complaint. Upon receiving a complaint, the RCMP or local police will enforce this Act.

2.3: Federal Government

Fisheries Act. The Fisheries Act is the main Federal Act that addresses pollution from farms.

This Act prohibits an unauthorized deposit of a harmful substance into water frequented by fish, as well as water that may eventually enter water frequented by fish. Shellfish are protected the same as fish. The Act also prohibits the harmful alteration, disruption or destruction of fish habitats. Therefore, any work in or about a fish watercourse requires pre-approval. Environment Canada has the lead role in the enforcement of the pollution control parts of this Act. Examples of potentially harmful substances are: manure and runoff from yard areas, milkhouse wastes, silage effluent, woodwaste leachate, pesticides, and improperly disposed mortalities.

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3: Pollutants

Some items that are produced or used on a dairy operation can cause pollution. These items when released to the environment in sufficient concentration are pollutants. This section explains the impact the pollutants have on: air, soil, and water.

3.1: Impacts on Air

Items that cause air pollution and where they come from are discussed below.

Burning. Burning introduces smoke and particulate matter into the air. Burning also releases global warming gases to the atmosphere.

Global Warming Gases. Certain gases in our environment act like a greenhouse, trapping the sun's heat, which then heats our atmosphere and causes global warming. This process is known as the greenhouse effect. The primary gases of concern are carbon dioxide, methane and nitrogen oxides.

Nitrogen Oxides. Nitrogen oxide emissions cause ground-level ozone formation during the summer. Elevated values of ground-level ozone have been associated with crop damage.

Odours. The importance of odours in human terms is related primarily to the mental stress they produce, rather than any physical harm. Offensive odours can cause poor appetite for food, lowered water consumption, impaired breathing, nausea and vomiting. Odours can be generated from livestock areas, manure spreading and from rotting feed.

Pesticides. Air can be polluted with pesticides by spray droplets, mists, dusts or vapours. Once in the air, they can be transported to water bodies, non-target organisms, or soil. They can also be concentrated within enclosed spaces and harm unprotected applicators, and non-target organisms.

3.2: Impacts on Soil

Items that can cause soil pollution and where they come from are discussed below.

Carbon:Nitrogen (C:N) Ratio. Soils have an equi-librium C:N ratio in the order of 12:1 to 15:1. The application of wastes with a higher C:N ratio (woodwaste has a C:N ratio of 300:1) will tie up free nitrogen in the soil. The continued application of such a waste will cause continued nitrogen tie up until a new soil equilibrium is attained. Soil with a high C:N ratio will have less nitrogen available for crop use.

Metals. Most metals are relatively immobile and crop uptake is small. Application of wastes containing metals will result in an unwanted accumulation in the topsoil. Crop yield reduction or toxicity can occur for some crops at relatively low levels of metals. If waste containing metals are applied to soil, precautionary measures must be taken. Once build-up has occurred and damage produced, it is too late to correct. Although levels in the soil may not harm plant growth, plant levels may be toxic to animals. Ingestion of soil by livestock may also lead to metal toxicity in animals. Some types of manure contain high levels of metals (mainly, copper and zinc). Waste oil and hydraulic fluids also contain high metal levels.

Nutrients. The primary nutrients are nitrogen, phosphorus, and potassium. The secondary nutrients are sulphur, magnesium and calcium. The micro nutrients are iron, manganese, boron, chlorine, zinc, copper, and molybdenum. If applied in excess amounts to soil these nutrients can reduce crop yields or become toxic to plants. Furthermore, when levels in the soil are not harmful to plant growth, nutrient levels in plants may be harmful to animals. The main source of nutrients is manure or fertilizer. Other sources include dead animals and feed.

Pesticides. Soil can be polluted with pesticides by spills during mixing and loading, application equipment overflow, improper disposal, or exceeding the proper rate of application. When pesticide pollution of soil occurs, beneficial insects may be killed, crops may not be able to be grown, or the type of crops may be limited. Animals or birds may also be harmed or killed by eating contaminated crops or soil. Animals or birds may suffer adverse effects such as weight loss or reproductive failure. They could also accumulate pesticides in their tissues, making them unfit for consumption.

Petroleum. Petroleum (gas, diesel, kerosene) and petroleum based products (oils, greases and solvents) are complex organic compounds

that contain metals and other contaminants. Many petroleum products are volatile which result in them being lost to the air. However, many more of these products either firmly or loosely bind to soil particles. In either case they will restrict the growth of plants. Petroleum products that are loosely bound to soil can be either washed or leached into surface or ground water.

Plant Diseases. Transfer of plant diseases is common in areas where farm equipment moves either from field to field or farm to farm. In many cases, bacteria, fungi or other organisms growing on the crop or in the soil are picked up by equipment. Plant disease organisms may also be transported from field to field by livestock. Contamination can result from plant diseases being moved in manure. Plant disease infestations can result in significant losses in crop quality and/or yield. Severe contamination may reduce the range of crops that can be grown.

Salts. The salt content of a manure depends on the feed constituents. Many manures contain between 10 and 13% salts (dry weight basis). High application of manure, annually applied, can increase soil salinity in areas of low precipitation. Many crops are adversely affected by elevated salinity levels.

Woodwaste Breakdown By-product. Woodwaste (sawdust, shavings, chips, hogfuel, bark, etc.) may be a useful soil conditioner, but can also have negative impacts on soil. When exposed to water, air and soil microbial activity, woodwaste breaks down and releases soluble compounds that can leadto contamination of soil. Some of these compounds, particularly tannins, tropolones and resin acids, are toxic to some plant life. Woodwaste breakdown by-products are also acidic and will cause metals and nutrients to be released from the soil. Because the breakdown by-products are leachable they can enter groundwater. High application rates of woodwaste to the soil surface or incorporated into the soil will cause nutrient imbalances or shifts in soil microbial populations. For example, a heavy application of sawdust that is incorporated into the soil will cause nitrogen deficiencies (see Carbon:Nitrogen Ratio) and may cause the soil pH to drop.

3.3: Impacts on Water

Items that cause water pollution, and where they come from are discussed below.

Ammonia (NH3). This chemical, which comes from urine or fertilizer, is highly toxic to fish. Runoff from over-fertilized crop land or from uncovered manure piles can have a high ammonia

concentration.

Metals. Metals include nickel, manganese, lead, chromium, zinc, copper, iron and mercury. Trace quantities of some of these metals are necessary for growth of biological life. However, the presence of any of these metals, in even slightly elevated quantities, can interfere with many beneficial uses of the water. Elevated levels of metals are toxic to most living things. Metals may come from manure, waste oil, hydraulic fluids or can be released from soils into groundwater by acidic leachate from woodwaste products.

Nitrate. Once applied to the land, the nitrogen in manure or fertilizer can convert to the nitrate (NO3) form, which is water-soluble. Because it is soluble, it does not attach to soil particles as ammonium nitrogen does, and so is easily leached from the soil. Once past the root zone, nitrates can continue moving downwards to the groundwater and into drinking water supplies. Nitrates, which are converted to nitrites in a baby's stomach, can cause a disease known as blue-baby syndrome. These nitrites reduce the oxygen-carrying capacity of the blood. In extreme cases, this disease can be fatal. After the baby is about six months old, its stomach becomes more like that of adults, and this disease poses less of a threat. Medical advice states that a nitrate nitrogen level over 10 mg/l in drinking water is a health risk. The tolerance level of livestock to nitrate nitrogen in water is higher than for humans. As much as 40 mg/l may be safe for cattle, providing that feed nitrate levels are low.

Nutrients. Nutrients (primarily nitrogen and phosphorus) accelerate eutrophication (rapid aging) of water bodies. Nitrogen can stimulate eutrophication in lakes, but phosphorus is generally the critical limiting nutrient. In streams, both nitrogen and/or phosphorus can be the limiting nutrient. The most visible effects of eutrophication are massive blooms of phytoplankton (algae). In some cases the blue-green algae are toxic to cattle. The nutrients can come from manure or fertilizer going directly into a watercourse, livestock area runoff or nutrient rich soil eroding off fields.

Oxygen Demand. Oxygen demand is measured by either BOD (biochemical oxygen demand) or COD (chemical oxygen demand). When waste enters a water body, its decomposition requires oxygen. This removes oxygen that would otherwise be available for fish and other aquatic life. Therefore, wastes with high levels of BOD when they enter a watercourse may kill fish. The BOD of dairy cattle manure is about 30 times higher than human waste. Wasted feed and silage juices can have BODs three to five times higher than manure.

Pathogens. All animal wastes contain micro-organisms such as

bacteria, viruses, and parasites. Some organisms in waste may be pathogenic (disease-causing) either to animals of the same species or of different species. In addition, more than 100 diseases are transmissible between animals and human beings. Although the water itself may not be affected by the organisms, the water becomes a path for transmitting diseases to animals and humans. Pathogens in cattle manure or from dead animals cause two water quality problems. Shellfish contamination occurs when pathogens enter estuaries by way of runoff, contaminating shellfish beds, and rendering the shellfish unfit for human consumption. Unsafe drinking water supplies occurs when pathogens contaminate surface or ground water.

Pesticides. Both surface and ground water can be polluted with pesticides. Pollution occurs by runoff or leaching of soil that has absorbed pesticides, and by direct application of pesticides to water, drift, or accidents such as spills. Once water is polluted, any organism living in the water or using the water may be affected. These include people, animals, fish, plants, birds and wildlife.

Petroleum. Petroleum and other oil substances can be harmful in water supplies. Oil in suspension can act on the gills of fish to interfere with respiration. Petroleum destroys algae and other plankton, thereby removing a source of fish food, and oxygen. Oily substances that settle can coat the bottom of a water body, destroy organisms, and interfere with spawning areas. Soluble and suspended materials ingested by fish can taint the flavour of the flesh or have a direct toxic action on fish or fish food. If films of free oil are present they can interfere with the natural processes of stream aeration and photosynthesis. Petroleum products are less toxic to humans and animals, however, some forms of petroleum have been linked to cancer.

Solids. Solids in water are present in two forms, suspended or dissolved. Examples of suspended solids are clay, silt, oils, pathogens, etc., whereas dissolved solids include nutrients, metals, etc. Either form of solids can be harmful to fish, especially ammonia which will readily kill fish. Other dissolved solids can cause the BOD of the water to rise. Suspended solids such as silt can damage the gills of fish or smother the eggs of aquatic life.

Woodwaste Breakdown By-products. Woodwaste (sawdust, shavings, chips, hog fuel, bark, etc.) may be a useful soil conditioner, but can also have negative impacts on soil. When exposed to water, air and soil bugs, woodwaste breaks down and releases soluble compounds that can lead to contamination of water. Some of these compounds, particularly tannins, tropolones and resin acids are toxic to some aquatic life. Woodwaste breakdown by-products have high

BOD, and COD levels are acidic and will cause metals and nutrients to leach out of soil. Because the breakdown by-products are leachable they can enter either surface or ground water. Woodwaste breakdown by-products cause accelerated fungal growth in receiving waters.

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4: Planning Facilities

This section contains general information on site location, building construction, watering, ventilation systems, and feed processing and storage for dairy operations. Other detailed construction information is available in publications and plans identified in Appendix E, Reference Material.

4.1: Site Planning

The importance of good farmstead planning cannot be over emphasized. Effort spent in carefully selecting a building site can result in reducing conflicts with neighbour and potential environmental problems (see Figure 4.1). New building sites should be selected after considering the following:

- Be aware of local government by-laws and Federal and Provincial requirements.
- Locate within the Agricultural Land Reserve and agricultural zoned land.
- Evaluate the land base available (deeded and leased) to ensure sufficient cropland is available to utilize agricultural wastes as an organic fertilizer for crop production. For more information, see Section 9, Land Application of Manure.
- Take advantage of prevailing winds to direct unavoidable production of dust and odours away from neighbours and the farm house.
- Take advantage of natural terrain and landscaping to minimize conflicts with neighbours over nuisances such as flies and odours. Air turbulence created by shrubs and trees will encourage dilution of odours.
- Locate on an adequately drained site, being careful to avoid low areas subject to flooding.
- Grade the area to divert polluted runoff into manure storages

and unpolluted runoff water away from the buildings and manure storage areas.

- Service the farm with a compacted, well drained gravel or asphalt roadway.
- Locate milking parlour and milking room at least 45 m (150 ft) from a building in which hogs or poultry are kept.

4.2: Building Construction

Design and construct buildings in accordance with the **Canadian Farm Building Code** (See Appendix E, Reference Material). In addition, all dairy buildings should meet local health and sanitation requirements. Some standard, conceptual, and leaflet plans are available from the BC Ministry of Agriculture and Food, Soils and Engineering Branch. Figure 4.2 shows a typical barn wall with environmentally sound construction.

To aid in sanitation and waste handling, dairy buildings should:

- have concrete foundation walls extending at least 0.3 m (1 ft) above the grade line;
- be kept in a proper state of repair;
- in high rainfall areas, have eaves troughs to divert roof drainage away from the building;
- in colder or drier areas, have gravel splash pads at the base of the wall for erosion control where roof runoff falls; and
- have adequate perimeter drainage to remove roof and surface water away from the building.

4.3: Ventilation

Control of the dairy cattle environment will affect productivity, animal comfort and feed conversion. This makes ventilation of the dairy barn an important part of overall management. A good ventilation system will:

- Remove dust, harmful gases and odours from the buildings.
- Maintain an adequate supply of fresh air within the building.
- Control the temperature and humidity of the air inside the building.

When properly designed, natural ventilation in single storey uninsulated barns is usually adequate. Ridge ventilators and perimeter ventilation inlets provide necessary air exchange with a minimum of draft discomfort to livestock.

Warm, insulated barns and barns with low ceilings will normally require supplemental ventilation supplied by fans. When fan ventilation is used, low level winter ventilation should be continuous. The higher levels required in the summer may be controlled by thermostats.

Where possible, to avoid nuisance conditions, exhaust fans should be located to direct discharge downwind from nearby residences and public places. To prevent backdrafts, shutters should be installed over exhaust ports. In buildings where dust and odour levels can be high, hoods on exhaust ports to direct the discharge down toward the ground may be beneficial. In all cases, hoods or protective flaps should be installed on all ventilation ports to prevent the entry of rain and snow, and to ensure predictable exhaust rates. For detailed ventilation information, refer to the BCMAF **Ventilation Handbook** listed in Appendix E, Reference Material. The Regulations Section of the **Milk Industry Act** sets the minimum standards for ventilation of the milking complex.

4.4: Feed

This section outlines the environmental aspects of handling and storing feed. Emphasis is on preventing feed wastes from contaminating water.

FEED HANDLING

Environmental concerns relating to feed handling are mainly due to wasted or lost feed. Feed is wasted or lost in the field, from storage or at the feedbunk. To ensure against surface or groundwater contamination, consider the following:

- Keep feed contained during transport.
- Clean up any feed spills before they can affect any water source. This will also reduce odours and rodent activity.
- Provide all weather roads between feed receiving, handling, storage and feeding areas.
- Have sufficient space for large transport vehicles to manoeuvre.

FEED STORAGE

Dairy cattle feed should be stored to prevent contamination of water sources. Most contamination is caused by leachate or runoff from the storage facility.

Hay Storage - Low Rainfall Areas. Consider the following points for hay storage structures in low rainfall areas:

- Choose a well drained dry site not subject to seasonal water flows (divert off-site runoff away from the site).
- Ensure any contaminated runoff from the site is controlled and handled (see Runoff Control and Collection in Section 7.4).
- Cover hay with tarps or a pole shed (usually worthwhile to reduce feed losses) and provide for roof runoff control using gravel splash pads.
- Provide all season access for transport equipment.
- Lay out the site to allow for cleanup of spillage.

Hay Storage - High Rainfall Areas. Consider the points listed for low rainfall areas plus the following:

- Covered hay storage is usually necessary to reduce feed losses. Leachate from the feed is of concern and covered storage reduces both feed losses and environmental risks.
- Pole barns must have roof runoff collected with eaves troughs to ensure drainage away from the structure.

Silage Storage - Low Rainfall Areas. Silage juices (effluent) is a more concentrated contaminant than manures and hence a pollution concern. If silagejuice is produced it should be collected and added to the manure storage. Consider the following points for silage storage structures in low rainfall areas:

- Choose a well drained site not subject to seasonal water flows (divert off-site runoff away from the site).
- Open pit storage is suitable in these areas.
- If silage is put up wet and silage juices are generated, a floor of concrete or other impervious material is required.
- Silo floors should be sloped to drain forward to the open end to avoid trapping rainwater and silage juices. This flow must be diverted away from watercourses and on to adjacent fields, etc. Large silos may require this flow be collected in a liquid storage facility.

Silage in plastic bags should be stored on sites similar to those indicated above with the following additional considerations:

- The base should be free of sharp rocks or other objects that might puncture the bags.
- The site should be fenced to prevent access by livestock and wildlife.
- The site should be kept free of ruts and weeds to discourage rodents.
- Where required, the site should be baited to control rodents.

- Bird damage usually occurs to the upper surfaces of bags and does not allow juice leakage, but can cause forage spoilage.
- Plastic should be collected and disposed of properly, refer to Section 11.9, Plastics.

Silage Storage - High Rainfall Areas. Consider the points listed for low rainfall areas plus the following:

- Covered pit storage may need eaves troughs for roof runoff control.
- Concrete or other impervious floor material should be used to collect silage juice.
- The floor should extend past the front of the silo to form an apron to manoeuvre on.

Grain Storage - All Areas. Grain should be stored in covered, rodent proof structures such as free standing wood or steel bins or temporary areas of barns. These structures can provide good environmentally sound containment.

FEED PROCESSING

Good storage and processing facilities for feed and feed ingredients are a sound investment. Adequate facilities and proper management can help avoid pollution and reduce losses due to spoilage, insect and rodent damage, and fire from spontaneous combustion.

Before building new feed storage facilities, a complete storage and handling system should be designed to meet both present and future requirements. When designing a storage facility mechanization needs to be considered. Choose a building site with good drainage, preferably elevated and easily accessible. Divert roof water and any other clean water away from the site.

All feed ingredients for processing, as well as processed and stored feed must be contained. Uncontained feed can contaminate surface or groundwater. If there is contaminated runoff that could cause pollution, it must be collected and stored.

To reduce odours, rodent activity and contaminated runoff, clean up spilled feed as soon as possible.

Consider locating the feed processing and handling centre in an area that will allow access of large vehicles. Sufficient setback from neighbours is important due to the increased noise level of operation, dust, traffic and the threat of a fire.

For more information on feed processing, handling and storage, see

the publication **Planning Grain-Feed Handling (MWPS-13),** listed in Appendix E, Reference Material. Information on obtaining this publication is available from the BCMAF, Soils and Engineering Branch office in Abbotsford.

4.5: Milking Centre

Milking centre wastes contain many ingredients that may affect the environment. Milk centre wastes may include manure deposited in the milking parlour, udder washings, spilled milk, and equipment washwater containing detergents, acids and chlorine.

Milking centre sanitation and the handling of dairy wastewater are largely controlled by the Milk Industry Act, Waste Management Act, and the Health Act. The following points are made to assist dairy producers in choosing a wastewater handling system.

- On dairy farms where manure is handled as a liquid, milking centre wastes should be directed to the manure storage facility. This volume can be significant, 20 to 45 litres (5 to 10 gal.) per milk cow per day. Therefore, care must be taken to ensure that sufficient storage space is available to handle this additional volume. See Section 8, Manure Storage.
- On farms that currently handle wastes as a solid or semi-solid, additional liquid is not wanted in the manure storage facility. In these cases, separate liquid storage for milking centre wastes will be required.
- Some existing facilities use a settling tank and a subsurface drainage field. This system will not meet the requirements of the Code of Agricultural Practice for Waste Management. Dairy farmers wishing to install such systems or continue this practice are required to contact the Ministry of Environment, Lands and Parks for a Waste Management Permit. If the milkhouse waste can meet the Ministry of Environment, Lands and Parks ground discharge requirements, the expected permit fee would be about $500 per 100 milking cows per year. Suspended milk solids in milking centre wastes tend to clog the tile field. As a result, tile fields often fail within one to five years of installation.
- Human sewage requires a method of disposal approved by the Ministry of Health. Adding toilet wastes to the manure pit is not allowed under the Waste Control Regulation.

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5: Housing and Waste Handling Systems

All dairy operations in the province include confined housing, feeding and milking facilities of some type. The storage of wastewater and manure are an important part of the overall management of these confinement facilities. This section discusses several housing and waste handling methods currently employed by dairy producers, and emphasizes the relationships between the design and operation of the waste system and the potential for polluting.

There are several methods of handling dairy manure. Most dairy farms in BC have chosen a liquid or semi-solid manure handling system. These systems require less labour than the solid manure handling systems used by some smaller dairy farms.

5.1: Free Stall Barns

In a freestall barn, cows find dry resting space in the stalls, but can wander out of the stalls at will for exercise and feed. Most dairy operations of over 50 cows now use free stall housing systems. The advantages claimed for free stall dairy housing are reduced labour requirements and fewer cow injuries.

Figure 5.1 is an example of a free stall dairy barn designed with slotted floors. In wet and cold climatic regions, cows are generally fed within a free stall barn. This will increase operator and cow comfort and reduce manure handling problems by keeping the manure contained. In all cases, cows are milked in a separate milking area that is often a part of the free stall building complex. Free stalls must be properly sized for the animals they will accommodate. They should be long enough to permit a cow to stand completely within the stall, but short enough to ensure that cows defecate outside the stall. If they are too long, a dirty area will develop inside the rear curb. When this happens this area may harbour disease producing organisms. The partitions should be shaped to discourage cows from turning around in, or backing into, the stalls. The curb end of the stalls should be at

least 150 mm (6 in) above the level of the alley to avoid spillage of manure into the stalls during the cleanout operation. Manure from free stall barns is usually handled as a semi-solid or as a liquid. Manure is removed from free stall barn alleys by tractor mounted scraper, alley scraper, flushing or by dropping through a slotted floor. The manure then either goes directly to storage, to a cross channel and then to storage, or to a holding pit and then pumped to storage. In slotted floor systems, dairy manure is stored under the slotted floor for up to seven months. A race track system allows manure to be easily agitated. For more information, see Engineering Factsheet, **Circulatory Agitation Systems for Dairy Manure Storage Tanks (383.510-1)** listed in Appendix E, Reference Material.

The cost of slotted floor housing is comparable to the combined cost of a conventional barn and an outside roofed manure storage having the same storage capacity. The slotted floor design is becoming more popular due to reduced labour involved in cleaning alleys, and also allows for an increase in stocking densities. The increased stocking density reduces the cost per animal unit for this type of housing.

GRAVITY FLOW SLURRY CHANNELS

Gravity flow slurry channels (see Figure 5.2) are a method of transferring liquid dairy manure from the barn to storage. Proper management of a slurry channel is essential for satisfactory operation. It is necessary that the channel be carefully designed and correct management followed for a trouble-free operation. For more information, see the Engineering Factsheet, **Gravity Flow Slurry Channels for Dairy Manure (383.350-1)** listed in Appendix E, Reference Material.

5.2: Stanchion and Tie Stall Barns

Stall barns are preferred by some dairy producers managing smaller herds, particularly in the colder regions of the province. Usually, cows are housed, fed and milked in the same stalls. The major problem with stall barns for dairy cattle has been the amount of hand labour required to feed and milk the cows. However, mechanization of stall barns is now possible to nearly the same degree as that of free stall barns. Both stanchions and chain or leather ties are used. Tie chains generally are preferred mainly for reasons of cow comfort. A tie stall barn is shown in Figure 5.3. Stanchions and tie stalls should be sized according to the size of the cows that will be housed. The stalls must be narrow enough and just long enough to ensure that manure is dropped into the gutter and not in the stall, yet they must not be so short that the cows are forced to stand in the gutter. Stalls should be

sloped toward the gutter to allow udder washings and urine to drain from the stalls. Gutters should be at least 300 mm (12 in) wide and should be 150 mm (6 in) deep, depending on the length of the barn. The bottom of the gutters should slope slightly toward one end to provide adequate drainage of liquids from the building. Gutters must be large enough and cleaned often enough to ensure that manure does not build up in the stalls or the alleyway or spill during the cleanout operation.

Where little or no bedding is used, manure in the gutter will be quite sloppy. In such cases, gutters should be covered with a grate to keep cows tails, udders, and feet out of the manure.

Manure from stall barns should be handled in as dry a state as possible. Flushing gutters and liquid storage systems are not recommended for stanchion and tie stall barns in BC. Mechanical gutter cleaners are commonly used to convey solid manure to an appropriate manure storage structure. Semi-solid manure may be removed from the tie stall barn alleyways either with mechanical alley scrapers or with a tractor mounted scraper.

Manure should be removed from the building frequently to prevent unnecessary odours and fliesand to ensure that cows are kept clean. Manure removed from the barn needs to be stored in a manure storage facility. See Section 8, Manure Storage for more detail.

5.3: Bedded Stall Barns

Both tie stall and free stall systems use bedded areas in maternity and isolation pens. Bedded loose housing barns are also used to accommodate smaller milking herds, young stock, or dry cows.

Whenever bedded stalls are used within warm confinement barns, there is a potential for odour and flies. Ventilation of barns is difficult when there are a number of wet bedded areas. These problems can be avoided either by the addition of fresh bedding to keep the manure pack dry, or by frequent manure removal.

When a bedded stall is to be left vacant for an extended time, the manure pack should be removed to prevent fly breeding within the pack. Individual maternity stalls should be cleaned out and fresh bedding added between each use.

Bedded stall housing systems will produce a solid type of manure that can be collected several times a week and taken to a solid manure storage facility.

5.4: Calf and Heifer Housing

Careful management of young stock is essential for a successful dairy operation. Calves are more susceptible to disease than older animals, making proper sanitation a necessity. Calves are usually housed in either individual stalls within the barn or in individual hutches.

CALF AND HEIFER BARNS

Calves often are kept in individual stalls after they have been weaned to help reduce the spread of disease. Calf are healthiest when kept dry, clean and out of drafts. Stalls should be cleaned and disinfected before housing each new calf. Simple calf stalls construction make through cleaning possible. Feeding and watering facilities within the stall need to be arranged to avoid faecal contamination. Generally, watering devices and milk buckets should be kept separate from feed troughs to prevent feed from getting wet.

Size bedded stalls to provide at least 1.9 sq m (20 sq ft) per animal for young calves and more as they get older. Drain the stalls, either by hard surfacing the floor, or by using enough bedding to absorb urine and other liquids. Hard surfaced floors should slope to the rear of the stall. Remove the manure from bedded stalls as often as necessary to keep the pens clean and dry, usually every other day. Manure removal may be done by manually forking the soiled bedding from the stall into a central alley and then taking it to an appropriate storage structure.

Only use elevated stalls with slotted floors in warm buildings, as they tend to be drafty. These stalls are essentially self-cleaning, and manure collects beneath the slotted floor portion. Manure from slotted floor calf stalls should be handled in as dry a form as possible. Flushing the manure out from under the elevated stalls is not recommended. Removing the large amounts of water in the air resulting from the use of a flush system requires higher ventilation rates, making it very difficult to keep the barn dry without drafts.

CALF HUTCHES

The calf hutch is a small structure for housing one calf at a time, usually outdoors, separating calvesfrom each other to minimize disease transfer. In parts of British Columbia, hutches may be the only calf facility on the farm. Figure 5.4 shows a typical calf hutch. Avoid areas for hutches that could receive roof water runoff or yard runoff. Divert clean surface water around the site used for hutches.

Locate calf hutches in an area where any contaminated runoff can be

collected. Face the open ends south for maximum warmth from the low winter sun. Set the hutches in rows running east to west, with enough space between so that each hutch can be moved sideways to new ground when calves are changed.

Start each calf in a separate clean hutch relocated on new ground. Bed generously for insulation with straw or shredded paper. When using woodwaste, refer to Section 11.3, Use and Handling of Woodwaste Products. In some areas of the province, sand is used as a substitute bedding to discourage fly activities. Flies are not attracted to sand as they are to a straw/manure mix. Once the fly season is over return to conventional bedding.

Collect manure and soiled bedding from under the hutch as well as from around the outside of the hutch and put it into a solid manure storage for eventual land spreading as a fertilizer.

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Environmental Guidelines for Dairy Producers

6: Sanitation

6.1: Odour Control

Odours associated with livestock operations are largely the result of gases produced from decomposing organic matter. When manure is decomposed in the presence of oxygen, termed "aerobic" decomposition, few malodorous gases are produced. On the other hand, the decomposition of manure in the absence of oxygen, termed "anaerobic" decomposition, results in the release of many odorous and sometimes dangerous gases, including ammonia, amines, hydrogen sulfide, mercaptans and methane. Anaerobic conditions occur when wet manure is piled in heaps, or when liquid manure is stored in deep tanks, for periods longer than about one hour. Where strong odours are considered a pollutant, a producer could be found in contravention of the Waste Management Act. Until better means of aerobic storage and handling are developed, the following are alternatives that a dairy producer can implement to minimize problems due to odours. Some of these measures were mentioned throughout the previous sections, but are repeated here to emphasize the importance for odour control.

- Handle solid manure in as dry a state as possible.
- Remove wet manure and feed from dairy buildings.
- Remove dead animals and afterbirth from the building and promptly dispose of them in an approved manner.
- Check the direction of the prevailing wind before agitating or spreading manure to minimize the blowing of odours and manure particles toward residences or public places.
- If a problem arises despite reasonable attempts to control odour by management methods, the use of chemical or biological odour control agents should be considered. Several such agents are available commercially, but they have been used in the past with varying degrees of success. Any odour control product should be evaluated on your farm before large quantities are

bought.

- Milking parlour drains should be properly sized, complete with traps.

6.2: Fly Control

Flies near dairy buildings and manure storage areas are a nuisance to farm operators and nearby residents alike. Furthermore, flies may transmit disease from one farm to another, and filth from the farm to public places.

A successful fly control program may involve one or more of the following measures:

- Regularly remove manure and wet feed from the building, at least once every 10 days during the fly breeding season.
- Prevent scattering of manure and feed outside the building during barn cleaning operations.
- Dispose of dead animals and afterbirth.
- Store manure in enclosed structures as recommended in Section 8, Manure Storage.
- Keep manure collecting areas dark.
- In many situations, regular spraying with insecticides may be necessary. Advice from a qualified pest control person should be sought before embarking on such a fly control program. Ensure that only approved chemicals are used.

Spraying is never a substitute for adequate cleaning.

Key fly control areas around a dairy include:

Calf pens and hutches. Calf housing areas with calf pens or hutches are often heavily bedded with straw and cleaned out on an infrequent basis. Because of this, calf pens are one of the main sources of fly breeding. To evaluate your calf pens,look at the bedding and see if there are maggots, which are flies in larval form. The best spots to check are around the water and along the fence edges. These areas are moist and get little traffic from the calves. If larvae are found, rid the area of the manure, and then treat the area with a larvicide.

Loafing areas. Freestall housing and loafing sheds can become fly breeding areas if the manure is allowed to accumulate. Manure should be cleaned out if larvae are found. A residual fly spray can be used on the walls, posts and beams. If the fly problem is severe, you may want to use a knockdown spray in the evening. A small pump-up sprayer can be used with the nozzle set to a fine mist or fog. Bait can be used

and should be placed in pans in areas that the cattle cannot reach.

Cows. Cows can be treated in a variety of ways. Backrubs and dust bags can be used in a forced-use situation. Cattle can be dusted by hand or sprayed with a high pressure sprayer. Ear tags can also be used, however, they are designed to control horn flies and will not have much effect on the flies around the barn.

6.3: Rodent Control

Rodents such as rats and mice are one of the most widespread and destructive pests in the world. They eat and contaminate vast amounts of food, destroy buildings and spread numerous diseases.

To effectively ward off rodent infestations, constant vigilance is necessary. Rats and mice can be destroyed or controlled only by a vigorous campaign consisting of all of the following

- rodent proofing buildings by screening ventilation ports and other openings in the buildings to exclude rodents.
- eliminating harbourages or nesting sites by:
  - maintaining buildings in good repair;
  - keeping the areas next to buildings free from weeds, long grass and piles of debris and boards.
- removing food and water supplies by:
  - avoiding spillage of feed both inside and outside the barns;
  - keeping all feeds in covered containers;
  - eliminating water sources such as leaky taps, sweaty pipes and open drains.
- maintaining good sanitation by:
  - removing dead stock and afterbirth as soon as possible (daily removal is the minimum);
  - keeping all garbage in covered containers and eliminate waste and trash.
- poisoning, fumigating and trapping in extreme cases. Poisons, fumigants or rodenticides may be dangerous to humans, pets and livestock. Employment of a professional exterminator to conduct a thorough program specific to your farm is recommended.

6.4: Dead Animal Disposal

The following applies to all dead cattle:

- Dead cattle should be removed from the building as soon as possible after death. Dead cattle may be carriers of disease and, if not promptly removed, will attract rodents and flies and

produce offensive odours.

- Dead cattle should be disposed of in an approved manner within one day after death. Where this is not possible, they should be frozen or stored in a covered container for disposal at a more convenient time. Under no circumstances should dead cattle be left lying around the farm buildings for an extended time.
- Dead cattle may be disposed of by delivery to secondary users such as rendering plants, delivery to local municipal refuse sites (dumps), or as a last resort, burial in on-farm pits.

SECONDARY USERS

In areas of BC where rendering plants exist there is usually a pick-up service for dead animals. For information on the location of a secondary user closest to your farm, contact your respective dairy association or the office of the BC Federation of Agriculture.

MUNICIPAL REFUSE SITES

In some cases, municipal refuse pits are made available to dairy producers for the disposal of dead stock. Dead cattle should be taken to the disposal area daily. Where daily disposal at the site is impractical, dead cattle should be stored in airtight containers and preferably frozen before disposal.

BURIAL PITS

Burial pits for dead cattle should be considered as a last resort in disposing of downed stock. Direct earth burial is not recommended because it attracts predators and is a potential source of pollution to groundwater. Before a dairy producer considers using burial pits as a disposal system, a Best Agricultural Waste Management Plan (explained in Appendix A) should be done for the farm. If burial pits must be employed, they need to be located at least 120 m (400 ft) from any well or spring used as a water supply and 30 m (100 ft) from any other surface water. Direct burial sites need to be staggered throughout the property, not crowded together, and dead cattle must be covered the day they are buried with approximately 1 m (3 ft) of earth.

A burial pit should contain no more than 700 kg (1,500 lbs) of dead cattle (one large animal). Burial pits should be used only at locations where the groundwater level is well below the pit bottom and where soil is well aerated. Do not dig a burial pit on a floodplain or in low-lying areas, where water can seep into the pit.

Trench type pits are no longer acceptable. They are unsafe, difficult to back fill in the winter, and are a source of potential groundwater pollution. Unearthing of dead animals by dogs and wild animals is a further disadvantage.

FEEDING TO PREDATORS

This is the least desirable disposal method and should not be used in most cases. There is a health concern if humans contact the carcass. Any use of a carcass to bait predators for kill is illegal unless done under BC Ministry of Environment, Lands and Parks supervision.

6.5: Afterbirth Disposal

After birth should be collected and deposed of within a day. Afterbirth can be disposed in the same manner as dead animals (see Section 6.4). Removal of afterbirth to manure storages is an acceptable means of disposal.

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Environmental Guidelines for Dairy Producers

7: Outdoor Areas

This section deals with the environmental concerns regarding the land areas used for dairy cattle. This includes grazing, seasonal feeding and confined livestock areas. It is important for dairy producers to understand how the Code (Appendix C) defines these three areas:

- **Confined Livestock Area.** This is an outdoor, non-grazing, non-crop area where livestock is confined by fences, other structures or topography. Dairy producers would most commonly know these areas as feedlots, paddocks, corrals, exercise yards and holding areas.
- **Seasonal Feeding Area.** This is an area used for both crop production and seasonally for feeding livestock. The livestock is primarily sustained by supplemental feed.
- **Grazing Area.** This is a pasture or rangeland area where livestock is primarily sustained by direct consumption of feed growing on the area.

7.1: Confined Livestock Area

Confined livestock areas are to be 30 m (100 ft) from any watercourse and dairy cattle can not have access to a watercourse for watering.

SOIL BASED YARD

Commonly used names for confined livestock areas are dry cow lots, outside loafing areas, exercise yards, and pastures. These yards give livestock room, fresh air and sunshine, a dry, clean place for lying down or freshening, and relief for feet and legs that have been on concrete.

Heavy traffic and sustained use in soil based confined livestock areas, especially when it is wet, either destroys the plant cover or leaves a cover that is only sparse and weedy at best. Soil compaction stops precipitation from infiltrating into the soil, causing ponding and

runoff.

When confined livestock areas become bare, wet and muddy they stop providing many of the benefits for which they were intended. Instead, they become detrimental to the health of animals that must wade through them. Another problem is that a considerable amount of manure and other waste accumulates on the soil surfaces. Many of these areas are situated next to a drainage ditch or stream where rain may wash manure into these watercourses. If this happens confined livestock areas become a source of pollution, one that can be readily identified by anyone who drives by. There are a number of ways to manage these areas so they can function as intended and not be a source of water pollution. The following are some recommendations:

- Abandon the current area being used if located next to a watercourse. Establish a new confined livestock area somewhere on the farm at least 30 m (100 ft) from ditches and streams. This is the simplest solution, especially if there is a well drained, elevated alternate site near farm buildings.
- Close open ditches and use buried pipe to carry water past confined livestock areas. This solution will only work where flow volumes are fairly low and ditches do not support fish stock. An approval from BC Ministry of Environment, Lands and Parks is required for any work in or about a watercourse.
- Exclude livestock from loafing pastures when conditions are wet, to prevent soil destruction. Either keep livestock in their normal confinement areas or develop sacrifice fields so livestock have a place to go that is neither on concrete nor in mud. Sacrifice areas should be covered with sawdust, shavings, or some other form of bedding to absorb wasteand provide drainage. At least once a year (preferably in the spring) the bedding material should be collected and spread.
- In all confined livestock areas manure must be collected and spread as a fertilizer. Numbers of livestock and frequency of use will determine how often the manure will need to be removed.
- Any contaminated runoff that might enter a watercourse needs to be collected and put into a manure storage structure. See Section 7.4 Runoff Control and Collection.
- To aid in general sanitation, heavy cattle traffic areas and the areas adjacent to feed bunks and waterers should be hard surfaced.

CONCRETE (OR HARD SURFACED) YARDS

Dairy cattle often are housed in an open yard area where they are fed

or exercised. If less than 37 sq m (400 sq ft) of space is provided per animal, the entire yard area should be hard surfaced. In high precipitation areas, large open yards are not recommended due to the large volume of runoff water generated.

When using concrete yards consider the following:

- The size of the yard area should be kept to a minimum to reduce the amount of precipitation that can mix with the manure, and to reduce the labour needed to keep the area clean.
- Clean water from roofs and from the surrounding area should be diverted away from the open yard so as not to mix with contaminated water within the yard.
- Runoff from the yard area should be contained in a suitable holding tank, or directed to the manure storage facility.
- The open yard area should be cleaned regularly by scraping the manure to an appropriate storage structure suitable for either semi-solid or liquid manure, depending on the system in use on the farm. Under no conditions should cows be permitted to stand around in an area where excess manure is allowed to accumulate.

7.2: Seasonal Feeding Area

This is an area used for crop production and used seasonally for feeding livestock that are primarily sustained by supplemental feed. Dairy cattle are allowed access to natural water. However, it is recommended to fence off accessible portions of the watercourse and provide livestock waterers. While feeding can occur in any season, these areas are most commonly known as overwintering sites. Seasonal feeding areas are normally identified with the beef cattle industry and not the dairy industry. For further information see the **Environmental Guidelines for Beef Producers in British Columbia** listed in Appendix E, Reference Material.

7.3: Grazing or Pasture Area

Grazing areas that dairy cattle use can take on many forms: areas for grazing or strip grazing, a fields where a forage crop has recently been removed, pasture lands, etc. In most cases, animals are removed from the grazing area to receive supplemental feeding in the barn.

Where rainfall is adequate or when irrigation is used, pastures have the potential for high productivity. Therefore, high stocking rates may be used over long periods. Animals do not excrete more nutrients then they consume in feed. With no supplemental feeding, manure nutrient

produced will not be greater than the nutrients used by the crop. When fertilizer is applied (in addition to the manure from the grazing cattle) care must be used not to exceed crop needs. For acceptable manure and fertilizer application rates refer to Section 9.5, Manure Application Rates.

When grazing cattle on high production pasture, consider the following points:

- Cattle should use livestock waterers where feasible. However, access to natural water sources is permitted.
- Ensure that no contaminated runoff from the pasture is allowed to enter any water course.
- Consider harrowing of pastures to break up manure piles.
- When irrigating pastures, apply water at a rate suitable for the soil and local climate to ensure no nutrient leaching. See the BCMAF, **BC Sprinkler Irrigation Manual** listed in Appendix E, Reference Material.

Dairy cattle are allowed access to natural water. However, it is recommended that accessible portions of the watercourse be fenced off and livestock waterers provided. For more information see the Engineering Factsheet **Why Keep Livestock Out of Watercourses? (386.000-1)** listed in Appendix E, Reference Material.

7.4: Runoff Control and Collection

Due to cattle densities, confined livestock areas require control and collection of runoff. The following discussion of runoff control is also relevant to grazing and seasonal feeding areas.

Perimeter Ditches. On-site runoff must be stored. Every effort to reduce the volume of off-site runoff coming onto the site will reduce storage size and costs. Therefore:

- All off-site runoff should be directed away from the confined livestock area wherever possible. Perimeter diversion ditches are the most common way of accomplishing this.

Grading for Runoff Control. If the yards are graded the on-site runoff will be easier to control. This requires a 2 to 4% slope down and away from the feed bunks. A similar slope is required from side to side along the back of the yard. Creating a diagonal path across the yard for water to run towards a collection system.

Runoff Collection. Runoff from each yard should be directed to a collection basin or to the manure pit for complete control. This will ensure that no contamination of surface or groundwater supply occurs.

Collection Basin Sizing. The size of detention basins to store runoff from confined livestock areas depends on the size of the runoff area and the amount of precipitation that occurs while storage is required. Under most British Columbia conditions, this critical period is the six winter months. Storing runoff for this period will avoid application of runoff on snow or frozen ground. Formulas can be used to obtain a design value for the amount of runoff. A local hydrologist can use these formulas, taking into account the conditions familiar to him. To obtain a first approximation for design, use the following formulas, and Example 7.1 as a guide:

For hard surfaced yards

V = A x P25

For non-hard surfaced yards

V = A x 0.9 P25

where using consistent units:

V	= volume of storage
A	= area contributing to runoff
P25	= the November to April (6 months) monthly total precipitation (rainfall plus equivalent water depth of snowfall) expected once in 25 years, shown in Table 7.1.

These formulas suggest that the design storage capacity be based on the most winter runoff expected in 25 years that may occur before emptying the storage in the spring. Between May and October, any runoff can be directly applied to crop land for utilization of the fertilizer nutrients without any need for summer storage.

Precipitation data for most locations in BC is available in the publication "Canadian Climate Normals" from Environment Canada or from the local BC Ministry of Agriculture and Food offices.

7.5: Feeding Dairy Cattle

Feeding losses have been estimated to range from 2 to 5% for forage fed in feeders, and from 10 to 50% for forage fed on the ground. While these losses are costly to a dairy cattle producer, they can also be of concern environmentally.

Feeding Hay, Silage or Grain. Slant bar and tombstone feeders are designed to reduce losses due to dropped hay. However, some losses still occur. Since manure tends to build up around feeders, consider appropriate feeder location. Permanent feeders on a Seasonal Feeding

Area require approval from BC Ministry of Environment, Lands and Parks before using.

Silage and grain are generally fed into a feeder or feed bunk; however, losses, may also occur from cattle dropping feed.

Consider the following points when selecting a feeding area:

- For seasonal feeding areas, choose a site that allows for feeding at a setback distance from watercourses greater than 30 m (100 ft).
- For confined livestock areas, choose a site where cattle are fenced 30 m (100 ft) away from watercourses.
- Choose a site that is well drained and not subject to seasonal flows or flooding.
- Clean up spilled feed regularly.
- Clean up wasted feed in the feeders periodically.
- Develop water supplies as outlined in Section 7.6, Watering Facilities.
- Handle runoff from the feeding area in such a manner that pollution does not occur. See Section 7.4, Runoff Control and Collection.

When feeding in an outdoor area, the following points should be considered to prevent water contamination from feed:

- Keep the feed site, feeder or feedbunk clean of wasted feed.
- Control runoff onto and off of the feeding area.

7.6: Watering Facilities

The following information relates to environmental concerns pertaining to watering facilities. For other water development information see the BCMAF publication **BC Livestock Watering Manual** listed in Appendix E, Reference Material. Water licences are required for surface water use in BC. An approval is also required for any work in or about a stream. The licence or approval is available from BC Ministry of Environment, Lands and Parks.

The Code of Agricultural Practice for Waste Management defines three types of land use areas. Water access differs for each area.

- **Confined Livestock Area.** Dairy cattle are not allowed access to natural watercourses.
- **Seasonal Feeding Area.** Dairy cattle may have access to natural watercourses under certain conditions.

- **Grazing Area.** Dairy cattle may have access to natural watercourses.

LIVESTOCK WATERERS

There is usually some risk of pollution when using natural sources. Livestock waterers are therefore the preferred method of watering cattle (where installation is feasible) to minimize this threat.

Depending on the site and location of the livestock waterers, consider these points:

- **Cost.** Materials and installation may be costly but justified by the advantages.
- **Pumping Energy.** Unless gravity flow is possible, many sites will require the water to be pumped.
- **Heating Energy.** The winter use of livestock waterers means that they must be frost proof. This requires either energy at the site or specially constructed livestock waterers.
- **Alternative Energy.** Both pumping and heating energy can be supplied by alternative energy sources. These non-traditional sources are discussed in the BCMAF BC Livestock Watering Manual and other publications listed in Appendix E, Reference Material.

Providing water to livestock with livestock waterers has some definite advantages:

- **Choice of Location.** Livestock waterers do not restrict the selection of yard areas.
- **Livestock Control.** Livestock activity can be influenced.
- **Protection of Natural Sources.** Stream and foreshore conditions may be improved, allowing vegetative growth and thereby reducing erosion concerns.
- **Winter Use.** Livestock waterers can be frost free for a convenient all-winter water supply.

When livestock waterers are used, the following points should be considered to ensure environmentally sound installations:

- Locate livestock waterers so manure that may accumulate cannot contaminate watercourses. This may require a set back of 30 m (100 ft) to a watercourse similar to the feeding setback.
- Install livestock waterers on a firm base, preferably concrete.
- Use a concrete apron or other suitable hard surface material around the livestock waterer to prevent soil damage and muddy conditions.

- Install livestock waterers to eliminate faecal contamination of the water and attendant disease and parasitic transmission problems.
- Where required, ensure adequate drainage for spillage or livestock waterer overflow. If the water overflow becomes contaminated it must be handled as outlined in Section 7.4 Runoff Control and Collection.

Be prepared for the following ongoing maintenance:

- Check float setting for proper water level (reduce spillage).
- Check for system leaks.
- Clean bowls regularly.
- Check power supply (when used).
- Check thermostats (when used).

Flow Through Livestock Waterers. Whether used for summer or for frost free winter use, flow through livestock waterers are very practical.

They are most commonly used when a gravity pressured water supply is available. The flow through principle is used for winter frost proofing. The heat available in the supply water flow is used to offset the heat loss from the livestock waterer by adjusting the flow passing through it. The main concerns are:

- The flow must be able to be stopped when not required.
- The outlet flow must be piped away from the livestock waterer.
- The outlet must be sized correctly to avoid spillage at the livestock waterer.
- The outlet flow must be secure from contamination (i.e., is not allowed to surface flow but is piped away from the watering area).

Cow-Powered Livestock Waterers. These livestock waterers are potentially useful on grazing areas or where energy is not available. They contain a diaphragm pump operated by a lever that the cow pushes with its nose in trying to reach the water in the bowl. Approximately one litre of water is delivered per stroke. The lift capacity of these pumps is up to 8 m (27 ft), (Note: this lift is reduced by elevation, friction, suction and other losses). Water can also be pumped horizontally depending on friction losses of the piping. A foot valve is used to ensure pump priming. Manufacturers estimate one livestock waterer can be used for 40 to 50 cows. Livestock will require some training to use this type of waterer.

Solar Powered Water Pumping. Another option in supplying

pumped livestock water is the use of solar energy powered water pumps. These are most appropriate when common electrical energy sources are either not available or gas and diesel sources are too expensive and inconvenient to use.

Photovoltaic solar panels that convert sunlight directly to DC electricity have been demonstrated to be practical for BC conditions. A number of systems are currently operating on Crown range and private grazing areas. System design and other information is outlined in the BCMAF publication **BC Livestock Watering Manual.** More detailed photovoltaic water pumping information can be obtained from the Soils and Engineering Branch, BCMAF.

Flow of Stream Pumps. Small flow pumps that are powered by flowing stream water may be useful to pump livestock water. These are generally untested in BC at this time but are used successfully in other countries. Flow rates are low but the pumping action is continuous. Water storage may be required to meet the peak flow requirements when cattle drink.

NATURAL WATER SOURCES

When livestock water directly from creeks or lakes, their presence can affect the water resource. The fishery, recreational, aesthetic and other values of the water resource must be maintained. This does not mean denying cattle the use of the water, but the producer must use environmentally responsible methods to water the animals.

Impact on Watercourses. The impacts to water- courses created by unrestricted access by cattle varies according to livestock intensity. This is recognized by the Code in the designation of three types of feeding areas and defining their respective access to watercourses. These impacts can result in a range of concerns depending on the severity of the impact and on the sensitivity of the watercourse. Management practices can help to reduce the impacts to watercourses.

The following are major concerns when watering from natural sources:

- Direct deposit of manure and urine into the water can have a number of harmful effects. Increasing the concentrations of nutrients, suspended solids, and bacteria in watercourses can contaminate water; harm fish and/or fish spawning grounds; increase algae growth; and destroy aquatic organisms.
- Deposit of manure onto lowland that is seasonally flooded by high water can wash contaminants into watercourses.
- Trampling of streambanks or lake foreshore immediately adds to the silt content of the water affecting fish stocks. Trampling

can also destroy streambank vegetation which is necessary to prevent erosion during freshet flows. Erosion affects both fish stocks and the adjacent farmland.

Reduction of Impacts. Proper development of a watering site on a natural watercourse will reduce or eliminate all these impacts. This is often the case when livestock waterers are installed. Undeveloped, natural sites can be made more environmentally sound if:

- Loitering is discouraged by feeding and providing salt sources well away from the water.
- Access to the watercourse is controlled by fencing.
- A gradually sloped access is chosen which can be cleaned regularly.
- Bank protection is added such as rip rap, gabions or logs (BC Ministry of Environment, Lands and Parks. (BCMELP) approval required)
- Gravel is added to improve footing in poor soils. (BCMELP approval required)

EXAMPLE 7.1

Determining Confined Livestock Area Runoff Volume

What volume of runoff will need to be stored for a 300 m2 (3230 ft2) paved yard area and a 400 m2 (4310 ft2) soil yard area on a dairy farm in Agassiz?

1. From Table 7.1, the precipitation for Agassiz for a winter six month period expected once every 25 years is 1610 mm.

2. To convert precipitation in mm to metres, divide by 1000

$$\frac{1610 \text{ mm} = 1610 = 1.61 \text{ m}}{1000}$$

3. For hard surfaced yards

$$V = A \times P25$$
$$= 300 \text{ m2} \times 1.61 \text{ m}$$
$$= 483 \text{ m3}$$

4. For soil yards

$$V = A \times 0.9\ P25$$
$$= 400 \text{ m2} \times 0.9 \times 1.61 \text{ m}$$
$$= 580 \text{ m3}$$

5. Total Runoff expected

= 483 m3 + 580 m3
= 1063 m3

Converting to imperial units 1063 m3 x 35.3 ft3/m3 = 37,500 ft 3

This dairy will require increased storage in an existing manure pit or a separate storage facility to hold 1063 m3 (37,500 ft3) of contaminated runoff expected from the two outside yard areas.

TABLE 7.1

October to March Precipitation For Predicting Runoff Volume

Location	6 Month Precipitation in mm		Location	6 Month Precipitation in mm	
	25 yr event	average		25 yr event	average
Abbotsford	1562	1091	Langley	1464	1052
Agassiz	1610	1120	Merritt	208	133
Aldergrove	1599	1185	Mission	1596	1139
Armstrong	325	247	Nanaimo	1151	867
Barriere	343	232	Penticton	236	145
Blue River	908	652	Pit Polder	2246	1638
Chilliwack	1715	1193	Prince George	417	291
Courtney	1563	1093	Quesnel	363	250
Cranbrook	324	205	Saanichton	886	643
Creston	429	308	Salmon Arm	422	300
Duncan	1180	832	Smithers	406	273
Enderby	454	274	Surrey	1344	969
Fort St. John	310	169	Terrace	1212	916
Grand Forks	310	169	Vanderhoof	315	211
Hope	2054	1284	Vavenby	314	197
Invermere	183	117	Vernon	298	205
Kamloops	192	119	White Rock	1073	762

To convert to Imperial Units 25.4 mm = 1 in

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Environmental Guidelines for Dairy Producers

8: Manure Storage

Dairy cattle manure is a valuable by-product of a dairy operation. However, to realize the potential value of the manure and to avoid pollution problems, there is a need for a well planned manure storage system. This section deals with sizing of manure storage facilities, stockpiling of manure, and manure storage structures.

All manure storage systems should be evaluated to ensure pollution is not occurring. The facility must meet the requirements in the Code of Agricultural Practice for Waste Management.

A storage facility (see Figure 8.1) is a permanent structure or location designed and operated to contain manure, other wastes, and contaminated runoff in an environmentally sound manner. The facility must be sized to hold wastes until they can be used as a fertilizer. Timing and amount of manure to apply on cropland is explained in Section 9, Land Application of Manure.

Field storage refers to temporarily piled manure, storaged in the field just before spreading on crop land. Only solid manure (manure with more than 20% solids) may be stored in a field storage. Field storages are not meant to replace storage facilities. They should only be used in the spring, summer and early fall. Field storage during the winter is not recommended due to risk of polluting surface and groundwater. In areas of high winter rainfall, (600 mm (24 in) or more precipitation during the seven months of October to April), the code requires field stored manure must be covered by, for example, a tarp. Field stored manure must not be located in low areas that are subject to flooding.

8.1: Manure Storage Capacity

Storage of manure is required during the times of the year when manure cannot be applied to cropland due to the risk of causing pollution. Ideally, a manure storage facility should be sized to contain a minimum of six months (180 to 210 days) of manure production.

This would allow a dairy producer to use manure as an organic fertilizer with the least chance of causing pollution. Manure storage durations vary depending on location in the province, soil type, soil temperature, crop grown, and local weather. Weather affects the ability of the producer to get onto the land to spread manure. There are situations where storage capicity of less then 180 days of waste may be acceptable. However, in those situations a Best Agricultural Waste Management Plan is recomended (explained in Appendix A, BCMAF Environmental Program.)

Design manure storages to take into account the highest rainfall that occurs over a 25 year period. In the south coastal area, most fields will be too wet to allow for spreading during late fall, winter and early spring. To obtain an estimate of the storage capacity required for a dairy operation:

- Multiply the suggested daily manure storage per animal found in Table 8.1 by the average number of animals on the farm to determine daily manure storage volume required for each size of animal.
- Determine the total daily storage volume by adding together the daily storage volume requirements for each size of animal and milking centre wastes as shown in Example 8.1.
- Multiply the total daily storage volume by the required storage duration (180 to 210 days) and add in any other wastes that need to be stored to obtain the total storage capacity required. This calculation is shown in Example 8.2.

8.2: Solid Manure Stockpiles

Long term storage by stockpiling waste directly on the ground is not recommended where pollution might occur. Stockpiling manure on the ground in areas of high rainfall or high watertables requires special management in order not to pollute. Stockpiles if used should:

- be located at least 30 m (100 ft) from any watercourse or well;
- be covered with tarps in areas of high precipitation or where runoff might occur; and
- be managed so pollution hazards are not created. If problems do occur, stockpiles may have to be replaced by a more conventional type of manure storage structure.

8.3: Manure Storage Structures

Runoff and manure storage structures, whether an earthen basin or a reinforced concrete tank, requiresimilar siting and sizing

considerations. These structures should:

- be located at least 15 m (50 ft) from any watercourse;
- be located at least 30 m (100 ft) from wells or domestic water intakes;
- be sized to provide enough storage that will enable the operator to spread manure during times when manure runoff from fields to surface water will not occur, and when crop uptake of the nutrients will occur;
- be either covered or open; if open the structure must contain the local expected winter precipitation;
- be structurally sound (consider professionally engineered designs for both earthen and concrete structures);
- be of watertight construction;
- be located, so that clean surface runoff from adjacent areas is excluded, land grading can also accomplish this;
- for contaminated runoff storage, be sized and located to contain all the once in 25 years runoff expected; and
- be adequately fenced to prevent the accidental entry of humans, animals or machinery.

The following discussion provides details on storage structures for various types of manure.

SOLID MANURE STORAGE STRUCTURES

Open type manure storage structures may be suitable in low precipitation regions of BC. If a problem arises an enclosed structure may be required. Open type manure storages should:

- meet the criteria listed in Section 8.3 for Manure Storage Structures;
- have a base of concrete or other impervious material and a curbed sidewall on at least two sides; and
- where possible be located out of sight and downwind from public places and neighbouring residential areas.

In areas of high precipitation, be adequately roofed to prevent the manure from becoming a semi-solid or liquid type manure (see Figure 8.2).

SEMI-SOLID MANURE STORAGE STRUCTURES

Manure scraped from some barns, and covered yard areas, may be handled as a semi-solid. Semi-solid manure storages are designed to permit tractor access as illustrated in Figure 8.3. Both earthbank and

concrete storages are used.

Earthbank Storages. These are very similar to solid manure storage structures except that they are able to contain manure that contains more liquid. Earthbank semi-solid manure storage should:

- meet the criteria listed in Section 8.3 for Manure Storage Structures;
- have a concrete floor (or other impervious floor), curbs and access ramp to allow easy access by a tractor and manure spreader; and
- if constructed in other than clay soils, where seepage may be a problem, be lined with an impervious material.

Concrete Storages. Semi-solid manure storages built with concrete should:

- meet the criteria listed in Section 8.3 for Manure Storage Structures;
- have reinforced concrete walls to contain the manure;
- have a concrete floor which is sealed to the walls to provide a manure tight storage;
- in areas with high watertables, be constructed entirely above ground to minimize seepage of groundwater into the structure;
- be roofed to keep out rain and snow in areas with high annual or seasonal precipitation;
- if roofed, be well ventilated to prevent the accumulation of hazardous gases in the head space area;
- have access doors constructed of tight tongue and groove pressure treated timber, or equivalent. Seepage, if any, should be contained by draining into a catchment pond or an underground concrete storage tank; and
- if fitted with a ramp, have guard rails and safety stops on the ramp to prevent a tractor from being buried in the manure.

In colder and drier regions of the Province, an uncovered, three-sided concrete storage structure may be suitable. These structures should:

- have reinforced concrete side-walls on three sides of the structure;
- have a concrete floor, sloping downward fromthe open side, which is sealed to the walls to provide a manure tight storage; and
- have provisions for control of seepage, if any, so as not to create a pollution hazard.

LIQUID MANURE STORAGE STRUCTURES

Liquid manure and contaminated runoff can be stored in earthbank storages, or in covered or uncovered concrete storages.

Earthbank Storages. Earthen lagoons for liquid manure or runoff storage should:

- meet the criteria listed in Section 8.3 for Manure Storage Structures;
- be constructed with a pumping dock to permit access by PTO driven pumping equipment; and
- if constructed in other than clay soils, where seepage may be a problem, be lined with an impervious material.

Concrete Storages. If concrete tanks are employed for storage of liquid wastes (illustrated in Figure 8.1), these tanks should:

- meet the criteria listed in Section 8.3 for Manure Storage Structures;
- be constructed of concrete with a rated strength of 20 MPa (3,000 psi) or greater (preferable 35 MPa 5,000 psi);
- if very large, have cross walls and/or baffles to facilitate agitation prior to emptying;
- if unroofed, be sized to allow for precipitation storage (designed for the highest winter precipitation during a 25 year period);
- if constructed entirely or partially above grade level:
  - have tight fitting closures on loading and/or unloading ports; and
  - be equipped with a manure level indicator that can be read from the ground;
- if uncovered and constructed with less than 1.5 m (5 ft) of the wall above grade level, be adequately fenced to prevent humans, farm animals, and machinery from accidentally falling into the tank;
- if constructed entirely below grade level, and covered:
  - have access ports covered with a minimum of 20 kg (40 lb) steel or equivalent childproof covers; and
  - have adequate surface drainage around the tank to prevent the entry of clean surface water; and
- if constructed below slotted floors within a dairy cattle building:
  - be sized to allow 300 mm (1 ft) of freeboard space at the top of the tank; and

- be adequately ventilated to prevent the accumulation of hazardous gases. Gases may accumulate in the head space area or in the area of animal occupancy.

TABLE 8.1 Average Daily Waste Production and Suggested Storage

Class of Dairy Animal	Daily Waste Production (Litres)	Daily Storage Volume Required (includes bedding and spilled water)		
		Slurry (Litres)	Solid Manure Handling(a)	
			Solid (Litres)	Liquid (Litres)
Dairy Calves 0 - 3 months old	6	6		
Dairy Calves 3 - 6 months old	8	11		
Heifers 6 - 15 months old	16	22	19	4
Heifers 15 - 24 months old	24	35	25	7
Dairy Cow avg. 640 kg (1400 lb)	60			
Free Stall		75	63	12
Tie Stall		67	8	
Loose Housing			75	
Milk Centre Wastes per Milking Cow	22 to 45			

To convert to Imperial units 1000 litres = 1 cubic metre = 35.3 cubic ft

(a) When manure is handled as a solid there is a liquid portion (urine) that may need to be stored.

EXAMPLE 8.1 Estimated Daily Waste Production from a Typical 100 Milking Cow Herd in a Free Stall Barn

Type of Animal	Number of Animals (Table 8.1) litres/day	Waste Production per Animal Produced litres/day	Total Waste
Milking Cows	100	75	7500
Dry Cows	13	75	975
Heifers (15-24 mo)	29	35	1015
Heifers (6-15 mo)	29	22	638
Calves (3-6 mo)	20	11	220
Calves (0-3 mo)	13	6	78
Sub-Total	204		10,426
Milking Centre Waste	100	30	3000
Total			13,426

Converting to Imperial units

$$\frac{13{,}426 \text{ litres/day} \times 35.3 \text{ ft3} = 474 \text{ ft3/day}}{1000 \text{ litres}}$$

EXAMPLE 8.2 Sizing a Dairy Waste Storage Facility

Assumptions: 100 milking cow herd
waste storage facility to be roofed
desire 6 months (180 days) storage
200 m2 (2150 ft2) outside yard area
1.6 m (63 in) precipitation over 6 months period (25 year event)
5,000 litres (175 ft3) silage effluent

(Daily Waste Production) x Storage Period (see example 8.1 above) = Total Waste Production Requiring Storage

13,426 litres/day x 180 days = 2,417,000 litres

Runoff Area x Precipitation (worst 6 months in 25 years) = Runoff Volume

200 m2 x 1.6 m = 320 m3 = 320,000 litres

Total Storage Volume	= Waste Production + Runoff + Silage Effluent = 2,417,000 litres + 320,000 litres + 5,000 litres = 2,742,000 litres
Converting to Imperial units	2,742,000 litres x 35.3 ft3 = 96,800 ft3 --- 1000 litres

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Environmental Guidelines for Dairy Producers

9: Land Application of Manure

Animal manure is a valuable source of plant nutrients and organic matter. Manure contains a vast array of organisms that add to the biological activity in soils. If not managed with sufficient care, manure can be a major source of pollution. Poorly managed manure will contribute to contamination of surface and/or groundwater. Maximizing the fertilizer value of manure also minimizes the environmental impacts.

This section provides information on composition and benefits of manure, factors affecting water contamination from manure, practical guidance on land application, manure application rates and manure spreading equipment.

9.1: Composition and Benefits of Manure

Manure management systems consist of various components including manure collection, storage, transport and land application. Manure is a dynamic organic material continually undergoing biological and chemical changes. Each phase of management may result in losses and changes to the beneficial nutrients in the manure. Therefore, the values of manure as a fertilizer depends on the quantity and form of nutrients present when it is applied to land. Table 9.1 shows the average amount of nutrients found in typical dairy cattle manure. This table can be used by crop producers who are using dairy cattle manure as an organic fertilizer. They can determine how much manure is needed to give the desired application of nutrients.

VALUE OF NITROGEN (N) IN MANURE

Nitrogen in manure exists in two forms, inorganic and organic. Inorganic nitrogen (ammonia) is the simple, soluble form that plants can use. After application to land, ammonia is converted by soil bacteria to the nitrate (NO3) form. Nitrate can be lost from the root zone through leaching or denitrification (loss to the atmosphere). Manure solids also contain nitrogen in the organic form. Until the organic matter is biologically decomposed in the soil, the nitrogen remains unavailable for plant use. Nitrogen in the organic form is desirable since it acts as a reserve in the soil and is slowly released for plant use.

Stored Manure. Dairy manure is stored primarily as a liquid, however there is still some storage of manure as a solid. Liquid dairy cattle manure loses some of the ammonia in it to the atmosphere (volatilization) while in storage. When the material is eventually spread onto land for crop production, much of the

remaining nitrogen is in the organic form and not subject to volatilization. The organic nitrogen compounds in dairy manure must be decomposed by soil microbes before they are available to plants. It can be assumed, as a general rule, that 60% of the nitrogen that enters the soil following application is available during the year of application. The rest of this nitrogen becomes available over the next three to five years. Solid dairy cattle manure loses much of the ammonia content while in storage. As a general rule, 50% of the nitrogen, following application to land, becomes available during the year of application.

If manure is applied during the fall or winter, it is estimated that up to one third of the nitrogen may be lost. The losses are due to leaching, denitrification and by runoff.

Grazing. Grazing animals deposit manure directly on the land in the form of urine and faeces. The nitrogen content of this manure depends on the size of animal, nitrogen content of the diet and consumption of water. The most significant factor governing the nitrogen content of the manure (especially the amount in urine) is the crude protein nitrogen content of the forage and other feed sources.

VALUE OF PHOSPHORUS (P) IN MANURE

Research indicates that 50% of total applied phosphorus in manure is available to the crop in the year it is applied. Most of the phosphorus contained in manure is in the organic form. Its availability is dependent on the rate at which soil organisms break down the organic material (mineralization) and release phosphorus.

Where dairy cattle manure has been applied regularly over many years, the phosphorus ÅfixingÅ capacity of the soil is reduced. On such soil, the availability of the phosphorus in manure approaches 100%. Producers should assume manure to be as effective as chemical fertilizer in supplying phosphorus to crops.

VALUE OF POTASSIUM (K) IN MANURE

All potassium in manure is available to the current crop. Soil that regularly receives manure is not often lacking in this nutrient. Grass tetany can be caused by cattle eating grass grown on soil with excess potassium. Potassium levels in forage grown in the south coastal area of BC have been increasing to cautionary levels in recent years. So soil testing and following potassium level recommendation is advised.

TRACE ELEMENT VALUE

The major fertilizer nutrients of manure are considered to be nitrogen, phosphorus and potassium. However, manure also contains the secondary nutrients sulphur, magnesium and calcium, as well as the micronutrients iron, manganese, boron, chlorine, zinc, copper and molybdenum. The availability of these elements as plant nutrients, varies depending upon soil type and soil acidity.

VALUE OF MANURE AS A SOIL CCONDITIONER

A positive benefit of applying manure to soil is the improvement of the soil's physical structure. The decomposition of manure by bacteria contributes to

improved aeration, improved permeability, and increased water holding capacity of the soil. Other soil conditioning benefits include pH buffering and an improvement to soils having high salt levels. When using manure as a soil conditioner, application rates must not exceed the nutrient requirements of the crop grown, and the manure must be incorporated into the soil.

9.2: Factors Affecting Water Contamination

SOUTH COASTAL REGION

Soil Characteristics. The proportions of sand, silt, clay and organic matter in a soil determine the water

and nutrient holding capacity. In general, mineral soils with a high clay and/or organic matter content have a relatively high capacity to hold water and nutrients in the root zone. Sandy and organic soils, on the other hand, have a low capacity. Therefore, the leaching of nutrients from sandy and organic soils during the winter months is much greater than from more heavily textured soils or mineral soils with a high level of organic matter. Leaching of nutrients from soils could result in groundwater quality degradation.

Drainage. Poorly drained soils become saturated during late fall, winter and early spring. After saturation, precipitation can no longer enter the soil. Therefore, water accumulates on the soil surface and eventually runs off into adjacent ditches or other watercourses. When this happens, materials, such as manure, that have been applied to the soil surface are removed with the water degrading receiving waters, or pond and contaminate ground water.

Compaction. Compacted mineral soil restricts water movement, become saturated at the surface and acts like poorly drained soil. Compacted soils are more susceptible to surface runoff.

Slope. If water does not infiltrate soil on sloping lands it must run off. If these lands become saturated, runoff is even greater. Material such as manure and nutrient rich soil particles can be eroded and removed with the runoff water. This could contaminate receiving waters.

Nitrate in the Root Zone. The nitrate form of nitrogen is of major concern due to its potential to contaminate drinking water. Nitrate is also the dominant form of nitrogen available to plants found in agricultural soils. Most of the nitrate in the root zone in the fall of the year is leached from the soil over the winter months. Where nitrate leaches from soils over sensitive groundwater acquifers or soils adjacent to surface waters, the nitrate will contribute to water contamination.

Excessive levels of root zone nitrate are found in soils where the spring application rates of manure and fertilizer have been high in relation to the ability of the crop to use the nitrogen. Excessive levels of root zone nitrate are also found in soil where there has been a fall application of manure after the cropwas harvested. Fall soil testing can give an indication of how well a producers nutrient application program is working.

Lack of Cover Crops. Permanent grasslands and, to a lesser extent, fall planted cover crops take up soil nitrates (and other nutrients) during fall, winter and early

spring. In addition, cover crops keep the soil surface open thereby reducing or eliminating ponding and surface runoff. Bare soil, on the other hand, is susceptible to leaching, surface sealing, ponding and runoff. Cover crops must be actively growing prior to September 15th if they are going to take any significant amount of nitrogen from the soil.

INTERIOR REGIONS

Spring runoff is the most important factor affecting water quality in the Interior Region. However, the factors listed for the South Coastal Regions also apply.

Spring Runoff. In the areas of the province where soils are frozen and snow accumulates during the winter months, snowmelt water can runoff the land into adjacent streams or bodies of water. Any manure that has been applied to the land since the previous fall can leave the land with the melt water and contribute to water contamination.

9.3: Monthly Environmental Considerations

JANUARY, FEBRUARY AND MARCH

South Coastal Region. If the land is subject to flooding and/or runoff, no manure should be applied because of the high risk of contamination of adjacent waters. If, however, flooding and runoff is controlled through adequate on farm and regional drainage systems, some manure can safely be applied on grassland or land seeded to an overwintering cover crop. Manure should not be applied to bare land, to frozen land or to land covered with snow where there is a risk of runoff.

Interior Regions. In most cases, manure application cannot be contemplated due to frozen soiland snow cover. If field access is possible, manure application should only be considered if there is minimal chance of runoff during the spring breakup period.

APRIL AND MAY

All Regions. On seasonal feeding areas collect and spread any build up of manure. On confined livestock areas remove and spread all manure.

On annually cropped land, apply and immediately incorporate the correct amount of manure. On grass land, apply the correct amount of manure. The correct amount of manure will supply the amount of nitrogen the crop removes, as calculated in Section 9.5, Manure Application Rates. Do not attempt to completely fertilize the crop with manure. Excess manure will result in a high rate of nitrate production in the latter part of the growing season and after harvest when nutrient uptake is minimal. Supplement the manure with fertilizer at planting or side dressing time.

JUNE, JULY AND AUGUST

All Regions. If manure must be applied, in most cases it can be applied only to grassland due to the presence of actively growing crops on other lands. Manure nitrogen efficiency for grassland can be greatly increased by irrigation

immediately following application. Nitrogen efficiency can also be increased by application of very wet manure slurries (more than 95% moisture content). Application of additional fertilizer nitrogen to grassland should be fine tuned according to the protein content of the forage. Grasses with a protein level of 20% are subject to a high probability of nitrate accumulation. High nitrate grass can be harmful to cattle. Care should be taken not to smother grass. Manure applications during the summer will likely supply most of the nitrogen requirements of the forage grass. This is particularly true on fields that have high organic matter levels or have a history of manure applications.

Although manure cannot be applied to annual crops during this period, crops can be supplemented with fertilizer nitrogen. A late spring soil test has been found to be useful in indicating whether a response to added nitrogen is to be expected. The critical level is 20 to 30 kg/ha (18 to 27 lb/ac) nitrate nitrogen in the plough layer 0 to 20 cm (0 to 8 in). Soil nitrate nitrogen below this range is usually deficient in nitrogen. Soils deficient in nitrogen require supplementation before the crop will achieve sufficient yield. Soil above this range will generally supply all the crops' nitrogen requirements.

SEPTEMBER AND OCTOBER

South Coastal Region. This is the most critical time of the year if manure is to be managed in an environmentally sound manner. On annually cropped land, crops have reached maturity and nutrient uptake has ceased. Soil temperature and moisture conditions are near optimal for formation of nitrates in the soil. Therefore, any added manure will only further contribute to the problem of fall nitrate levels and winter leaching.

If manure must be applied during this period, it should be restricted to grasslands that are well drained and not subject to flooding or runoff. Grasses are still actively growing and their roots will capture much of the nitrate and prevent leaching. Even so, only 40% of the annual allowable appli-cation should be spread in the fall and winter periods.

On other lands, winter cover crops must be planted before any application should be contemplated. Only spread manure on cover crops that are well established prior to September 15. These crops can act as Åcatch cropsÅ to catch the nitrate in the root zone and reduce leaching. Rates of application on these lands should be significantly lower than on grasslands due to the more immature root system.

Interior Regions. Because of frozen soils and low winter precipitation, winter losses of nitrate due to leaching are minimal. Therefore, a high percentage of any nitrate left in the root zone following harvest will be retained for subsequent crops. A fall or spring soil test will assist producers to take advantage of nitrogen from manure and reduce the need for fertilizer nitrogen.

NOVEMBER AND DECEMBER

South Coastal Region. With the onset of winter, soil cools to the point where there is very little formation of nitrate in the root zone. However, many soils are now too wet to allow ready access for spreading without causing severe soil compaction. If, however, the soil is sufficiently dry to support traffic, and flooding and runoff never occurs due to adequate on farm and regional drainage

systems, some manure can safely be applied on grassland or land seeded to an overwintering cover crop. Manure should not be applied to bare land. No more than 40% of the annual allowable application should be spread between the September to December periods.

Interior Regions. See January, February and March.

9.4: Environmentally Sound Manure Management

The following must be taken into consideration if manure is to be managed in an environmentally sound manner.

LONG TERM MANURE STORAGE

Maximum benefit is derived from manure when it is spread on the land in spring or summer. At this time leaching and runoff risks are low and crop growth and nutrient uptake is high. Adequate storage makes this possible by allowing more flexibility in choosing the correct time to apply the manure. See Section 8, Manure Storage.

ADEQUATE LAND BASE

To adhere to the recommended application rates, sufficient land must be available for the safe use of the amount of manure produced each year (see section 9.5, Manure Application Rates).

INCORPORATION OF MANURE

Incorporation either by injection, plough down, other tillage methods or irrigation should bepracticed to maximize nutrient recovery by minimizing ammonia losses. In addition the likelihood of manure runoff and the generation of odours is reduced.

PREVENT WATER CONTAMINATION

To prevent water contamination dairy cattle manure should **not** be spread:

- within 5 m (17 ft) of a bank or a slope leading to any watercourse;
- within 30 m (100 ft) of streams flowing into shellfish growing areas or any well or spring used as a domestic water supply. These distances should be increased where the ground slopes toward the stream, watercourse or well;
- on steep slopes where erosion and/or surface runoff is likely to occur;
- on saturated soils, where manure will not infiltrate into the soil;
- within the high water mark of field depressions during times of the year when there is a high risk of direct surface runoff to a watercourse;
- in excess winds where drift can occur;
- on frozen or snow covered ground where runoff of snowmelt to open watercourses might occur; and
- on areas having standing water.

ODOUR CONTROL

Land applications of manure from intensive livestock production facilities frequently lead to complaints. Consideration of neighbours with respect to time of day and weather conditions when spreading manure can do much to avoid conflict. Longer storage periods to reduce the frequency of spreading, as well as immediate incorporation of the manure into the soil to minimize odour is encouraged.

The following spreading techniques should be considered to reduce odour nuisance problems.

- Apply manure early in the day when air is warming and rising and diluting odours, rather than later in the day when air is settling, cooling and concentrating odours.
- Try to spread on a cool day when odour production is lower.
- Try to spread all the manure in as short a time as possible.
- Whenever possible, avoid spreading manure on weekends or holidays particularly on sites with neighbours nearby.
- Use rapid cover techniques such as discing, ploughing down or soil injection.
- Spread on days when wind will not carry odours or manure particles into public places, roads or neighbouring lands.
- Irrigate after spreading or apply dilute slurry.

9.5: Manure Application Rates

Management is the key to using manure to promote crop production and soil improvement while minimizing any hazard to the environment. Management means application of manure at rates and times of year that:

- are compatible with the nutrient requirements and growing characteristics of the crop;
- take into account soil characteristics, drainage and the slope of the land; and
- recognize the need to protect the quality of surface and groundwaters.

The amount of dairy cattle manure applied each year should be governed by the amount of nitrogen removed in the harvested portion of the crop. If the amount of nitrogen applied exceeds crop needs, then, over time, nitrogen losses to the environment will be excessive.

There are a number of factors that influence suggested application rates. Factors include the amount of nitrogen in the soil, the amount of manure added in previous years, the length of time manure is left on the soil surface before incorporation, the amount of crop refuse left in the field, and the presence or absence of a winter cover crop. For more detailed information see Appendix D, Dairy Cattle Manure Land Application.

Manure application rates are based on nitrogen. It is not a requirement to balance the other nutrients in manure to the crop utilization. This means thatexcess phosphorus will usually be applied to the soil. If the phosphorus does not run off the soil, pollution is not likely to occur.

Manure Application Rates To Grassland. Well managed, productive grass swards with extensive root systems have a high requirement for nitrogen and are very efficient in taking nitrogen compounds from the soil profile. Therefore, leaching losses are generally low under productive grass swards. The low leaching losses of productive grass stands allows this crop to receive a higher manure nitrogen application rate per unit of nitrogen removed by the harvested portion of the crop as compared to other crops.

Some fall and winter applications of manure can be considered if the following conditions are met:

- the land is not subject to flooding or runoff;
- the grass sward is managed for high yields and all vegetative growth is removed from the field during the growing season;
- the grass sward is not used for grazing; and
- application of manure does not harm the sward by smothering and scorching.

Land Area Suggested for Manure Spreading. Any dairy operation spreading manure on less land than required should request a "Best Agricultural Waste Management Plan" (explained in Appendix A, BCMAF Environmental Programs). To determine the amount of land required see the following formula. Land areas required for manure fertilization are discussed for confined livestock areas, and grazing areas.

CONFINED LIVESTOCK AREA MANURE

Cattle in confined livestock areas are contained indoors, or on sites where no crop is grown, or on sites where a crop is grown but the amounts of manure nutrients applied exceed the crop requirement. Manure from cattle in confined livestock areas needs to be collected, stored and/or spread as a fertilizer onto cropland.

Manure application rates were developed using "animal places" of manure nitrogen produced by one milking cow (see Table 9.2 for animal place equivalents).

Acceptable minimum area required to spread manure from a dairy cattle herd can be calculated using the following formula (see Example 9.1).

$$\text{Land Required (Hectares)} = \frac{\text{Animals}}{\text{Manure Units per hectare}}$$

- Animals are either the number of milking cows for a typical herd (typical herd shown in Example 8.1) or the total number of animal places on the farm. See Table 9.2 for animal place equivalents.
- Manure units per hectare are shown in Table 9.3. A manure unit is defined as the annual amount of manure produced by:
  - a milking cow and associated dry cows and offspring for the typical herd; or
  - an animal place.

It is recommended that all the manure be applied in the spring before crop growth. This will result in optimum crop yields without any risk of nitrate leaching over the fall and winter period. If manure application is split between spring and fall, leaching hazards will increase. Fall and winter applications should be less than 40% of the total amount of manure applied during the year.

GRAZING AND RANGELAND AREA MANURE

Intensively Managed Pasture. Maximum productivity of intensively managed pasture is achieved through use of irrigation water and regular applications of nitrogen fertilizer. Since the forage is not mechanically harvested and conserved, some of the nitrogen in the forage is returned to the land in the form of manure. Research indicates that the potential for environmental contamination is greater from grazing systems than from systems where the forage is removed from the land. Therefore, it is important to ensure that the amount of supplemental fertilization corresponds to the amount of nitrogen removed in the milk or meat produced plus the amount lost through volatilization.

Table 9.4 provides guidance on fertilization rates based on crop growth potential and time that the cattle are on pasture (see Example 9.2). It is assumed that stocking rates are sufficient to harvest the entire amount of grass produced. If stocking rates are excessive and cause harm to the grass stand, then the site is more correctly characterized as a confined livestock area. If the pasture is only grazed part of the time and mechanically harvested the rest of the time Table 9.4 does not apply.

Crop growth potential is an estimate of the amount of grass that could be harvested had the grass stand not been grazed.

9.6: Manure Spreading Equipment

Common ways of spreading manure include box spreaders for solid manure and vacuum tankers or irrigation systems for liquid manure.

Vacuum tankers provide the option of broadcasting or injecting the manure. Injection systems are gaining popularity as producers become more concerned about nutrient retention and odour control during spreading. A vacuum tanker with a grass land applicator is shown in Figure 9.1.

During manure application the following items should be considered:

- Apply the correct volumes per hectare as calculated in Section 9.5.
- Apply manure uniformly so as not to over-apply in some areas and underapply in other areas.
- Apply at rates that do not exceed the infiltration rate of the soil.
- Operate the application equipment so that spray drift does not enter a watercourse or leave the property.
- Reduce soil compaction by not driving repeatedly over the same areas of the field with heavy tanks of manure.

Dairy manure spreading equipment should:

- be of tight construction so manure will not spill from it during transport;

- be operated in such a manner that the wheels do not carry manure onto public roadways;
- be filled in such a manner that manure does not spill from the sides of the equipment creating unsanitary, messy conditions; and
- manure irrigation equipment should have all connections securely fastened to avoid leaks that could contaminate water.

TABLE 9.1 Typical Nutrient Content of Stored Dairy Manure(a)

Housing System	Moisture Content (%)(b)	Nitrogen		Phosphate Total as P2O5 kg/tonne	Potash Total as K2O kg/tonne
		Total kg/tonne	Ammonia kg/tonne		
Free Stall	91.4	2.9	1.5	2.1	4.5

To convert to Imperial units 1 kg/tonne = 2.0 lbs/ton

(a) Data collected by the Dairy Producers Conservation Group
(b) If the moisture content of the manure is different than the value shown, the nutrient content per tonne will also change.

TABLE 9.2 Animal Place Equivalents

One Animal Place Equals:	1 Milking Cow or 2 Dry Cows or 2.5 Heifers or 6.9 Calves
1 milking cow and associated dry cows, heifers, and calves	= 1.35 animal places

EXAMPLE 9.1 Calculating Minimum Area Required for Spreading Dairy Manure

What is the minimum area of grass land required for a typical herd of 100 milking cows? Assume the manure is from a typical herd as shown in Example 8.1, and the manure is applied to a 12 tonne/ha grass crop.

Grass crop (12 tonnes/ha): Table 9.3 value = 2.1 milking cows/ha
Farm Size (number of animal places): 100 milking cows
Land Requirement = 100 milking cows / 2.1 milking cows/ha = 47.6 ha

Conversion to acres = 47.6 x 2.47 ac/ha = 118 ac

The annual manure produced from this typical 100 milking cow herd should be spread on a minimum of 47.6 ha (118 ac) yielding 12 tonne/ha of grass.

TABLE 9.3 Acceptable Application Rates of Dairy Manure to Various Crops (a)

			Manure Units to be Applied per Hectare

Crop	Yield (tonnes per hectare)	Nitrogen Removal (kg/ha)	Milking Cows (for typical herd(b)	Animal Places(c)
Cereals - grain only	5	100	0.7	1.0
Cereals - whole crop	5	80	0.6	0.8
Grass(d),(e)	16	384(f)	2.7	3.7
Grass(d),(e)	12	288(f)	2.1	2.8
Grass(d),(e)	8	192(f)	1.4	1.9
50% Grass 50% Legume(d)	12	144(f)	1.0	1.4
Silage Corn(d)	20	256	1.9	2.5
Silage Corn(d)	15	192	1.4	1.9
Broccoli	12	120	0.9	1.2
Brussels Sprouts	13	130	1.0	1.3
Cabbage	60	220	1.6	2.1
Carrots	40	120	0.9	1.2
Cauliflower	16	100	0.7	1.0
Lettuce	60	150	1.1	1.4
Onions	55	150	1.1	1.4
Potatoes	50	230	1.6	2.2
Raspberries	9	70	0.5	0.7
Sweet Corn	20	160	1.1	1.5

To convert to Imperial units 1 Tonne/ha = 0.45 ton/ac 1 kg/ha = 0.89 lb/ac

(a) See Appendix D for description of assumptions used. This table is based on crops grown on soils with more than 10% organic matter. These soils provide 29% of the crop Nitrogen requirements. For other conditions see Appendix D.1. Detailed Calculation.
(b) Typical herd shown in Example 8.1. One milk cow in the typical herd represents 1.35 animal places.
(c) See Table 9.2
(d) Yield is in dry matter.
(e) The volume of dairy manure required to achieve these application rates may harm the grass stand due to smothering. If smothering occurs, rates of application must be reduced (see Section 9.5). In some parts of the province potential grass yields may be lower than those shown above. In such cases manure application rates must be reduced accordingly.
(f) Nitrogen removed has been increased by 25% to account for increased volatilization losses of nitrogen.

EXAMPLE 9.2 Fertilizer Nitrogen Calculation for Dairy Cattle on an Intensively Managed Pasture.

How much inorganic fertilizer should be added to a pasture that has a crop growth potential of 12 tonne/ha (5.4 tons/ac) that cattle are intensively grazing for five months?

Suggested Maximum Nitrogen Fertilizer = Table 9.4 value
= 130 kg/ha Fertilizer Nitrogen

Conversion to lb/ac = 130 kg/ha x 0.9 lb ha
----------ac kg
= 117 lb/ac Fertilizer Nitrogen

In order not to have excessive losses of nitrogen for this field, no more than 130 kg/ha (117 lb/ac) fertilizer nitrogen should be added.

TABLE 9.4 Fertilizer Nitrogen Guide For an Intensively Managed Pasture (a)

Crop Growth Potential (t/ha dry matter)	Length of Time Cattle on Pasture (months)					
	1	2	3	4	5	6
	Required fertilizer nitrogen (kg/ha)					
4	9	17	26	35	43	52
6	13	26	39	52	65	78
8	17	35	52	69	87	104
10	22	43	65	87	108	130
12	26	52	78	104	130	156
14	30	61	91	121	152	182

To convert to Imperial units 1 kg/ha = 0.9 lb/ac
1 t/ha = 0.45 tons/acre

(a) See Appendix D for description of assumptions used.

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Environmental Guidelines for Dairy Producers

10: Composting of Manure

Utilization of manure as a fertilizer for crop production is generally recommended at this time. However, cases do exist where insufficient crop land is available to recycle all manure as a fertilizer. An alternative to direct land application of dairy cattle manure is to compost the manure for off farm use. Usually if manure can be land applied, composting is an unnecessary expense.

In some cases, manure containing bedding (woodwaste or straw) is composted prior to land spreading. This helps to break down the bedding material.

Composting is a process that converts one form of organic matter into a more uniform and relatively odourless substance called humus or compost. The compost has considerable value as an organic soil conditioner and fertilizer.

Windrow composting involves the placement of the manure on an all-weather surface in long rows. Typically the rows are 1 to 2 m (3 to 6 ft) high, and 2 to 5 m (5 to 16 ft) at the base. The piles are turned periodically to mix and introduce air to the composting mixture. This helps to ensure that all the material is uniformly composted. Although mixing can be accomplished with regular farm equipment, the use of specialized equipment is usually more efficient. Windrow composting is relatively simple and inexpensive, but takes up to several months for completion. To hasten the process, complex high rate composting systems have been developed that can mechanically mix and aerate the composting materials. These systems are expensive, but could be practical on some larger dairy operations.

To ensure that pollution is not created at the composting site, ensure that:

- The site is located a minimum of 15 m (50 ft) from a watercourse, and 30 m (100 ft) from wells used for domestic purposes.
- Windrows are not located on coarse textured or gravelly soils.

- All clean surface water is diverted away from the composting site.
- All contaminated surface runoff from the composting area is contained to prevent flow into a surface watercourse. Contained runoff must be land spread according to the principles in Section 9, Land Application of Manure.
- Raw and composted material is stored in a suitable storage structure as outlined in Section 8, Manure Storage.
- In areas of high rainfall, a roof over the composting area may be required to keep the compost from becoming too wet. A roof reduces the amount of polluted runoff and leaching that must be stored.
- In areas of high rainfall, the storage of finished compost should be under a roof.

The value of the compost will vary and may require testing before spreading. Commercial composting facilities that receive manure or other wastes from more than one farm require a permit under the Waste Management Act. Note: At the time of writing it is proposed that all composting facilities (including agricultural types) will be required to register with BC Ministry of Environment, Lands and Parks.

For further information on composting, see the BCMAF **Agriculture Composting Handbook** listed in Appendix E, Reference Material.

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Environmental Guidelines for Dairy Producers

11: Other Environmental Considerations

This section deals with a number of other environmental considerations. These include soil conservation, gases that cause global warming, woodwaste products, other farm animals, pesticides, chemigation, farm medical wastes, petroleum products, plastics, burning and gyproc paper.

11.1: Soil Conservation

Any consideration of farming activities from an environmental perspective must consider soil conservation. Soil conservation includes any soil management practices that minimize soil loss from erosion, reduce degradation from acidification, salinization, and compaction, and increase the overall organic matter and fertility status of the soil.

Soil conservation practices are site dependent. They depend on soil and landscape conditions, type of farming operation and the critical factor of climate. In many instances it is the apparent disregard of the climate that is the major cause of soil degradation. Provisions must be made to protect the soil resources from degradation, (particularly due to rain drop impact), and rainfall or snowmelt runoff.

Soil degradation from acidification, salinization, organic matter depletion and compaction has a great impact on soil productivity on the farm. Soil erosion will have obvious and significant impacts on the farm, ranging from loss of nutrients and organic matter to the complete loss of crops and land. Off-farm impacts can also be very significant.

Soil eroded from farm fields that enters surface water can be considered a pollutant. Eroded soil is a pollutant if the concentration of either sediment or colloidal material affects fish and/or their habitat. These eroded soils can contain pesticides or nutrients that could be more harmful to the surface water ecosystem than the soil

material itself. Deposition of eroded soil can lead to expensive and unnecessary maintenance of roads and drainage systems.

Most soil degradation on dairy operations will likely occur as soil erosion and compaction. Erosion isprimarily caused by snowmelt or heavy rainstorm events. Compaction can occur on cropland and grazing areas due to tillage, manure application harvesting equipment traffic or livestock activity.

SOIL EROSION

To reduce the risk of soil loss due to runoff water in diversion ditches and on fields, the following factors should be considered:

- **Soil texture.** Fine textured soils are more erodible. The greater the percentage of fine sand, silt or clay in soil the greater the risk of erosion.
- **Topography.** Generally the greater the slope the greater the risk that erosion will occur. Slopes greater than 5% are considered to have a moderately high risk of soil loss if left bare. Slope length is also a factor, for example, when slope lengths are greater than 100 m (300 ft) the risk of soil erosion is higher.
- **Potential Water Volumes.** High intensity, short duration rainfall events in summer or snow melt runoff on frozen soil can result in severe erosion.
- **Surface Cover.** Generally the greater the amount of soil surface covered by vegetation, the less the risk of soil erosion. Permanent grass cover has a low risk, while temporary cover crops or straw mulch have a moderate risk. Bare soil has the highest risk.
- **Soil Condition.** Saturated, compacted or frozen soils are more susceptible to erosion because water is forced to flow on or near the soil surface.

Most runoff occurs as a result of severe rainfall events. It maybe necessary to reduce the velocity of the flow and contain the flow in a structure or ditch. A properly designed ditch or grassed waterway will contain and control the flow. This water can be diverted to fields or watercourses if it remains uncontaminated. If the runoff is coming off a recently manured field the water should be contained as it will likely be contaminated with manure. Diverting runoff water to either containment lagoons (pits) or cropland is the proper method of handling contaminated water. However, building containment facilities for field runoff is costly, an alternative is not to spread manure on fields if runoff from the field is expected within two

weeks.

More detailed information on soil conservation practices can be obtained from references such as the **Soil Management Handbooks** for either the **Lower Fraser Valley** or the **Okanagan and Similkameen Valleys**. These handbooks are listed in Appendix E, Reference Material. Factsheets detailing the design and construction of grassed waterways, ditches and diversion structures are also available.

The following are some prevention and abatement measures to control soil erosion by water.

- Avoid tillage or excessive grazing activities that would leave bare soil, poor crop growth or poor crop residue cover late in the season.
- Use permanent pasture, rapid growing cover crops or water control structures to protect highly erodible sites.
- Use contour tillage and drainage systems to reduce saturated soil conditions and runoff.
- If soil is left exposed by an unforeseen soil management or crop production problem, attempts should be made to incorporate straw into the soil surface. Any tillage to incorporate straw should be on the contour. Efforts should be made to divert any runoff containing soil to a settling pond prior to discharge.

SOIL COMPACTION

Soil compaction refers to the disruption and reduction of the large pores within the soil. The presence of excess soil moisture at the time of any field operation is the main factor leading to soil compaction. Once soil is compacted it is very difficult to reverse the effects of the compaction. Soil compaction is a serious, yet often invisible soil degradation process. Compacted soil can be recognized by high bulk density, poor rooting, poor drainage, and reduced crop yield.

Compaction may be the result of natural soil formation processes but is most likely due to cultivation practices. Lack of drainage leaves thesoil moist. Moist soils are easily compressed by traffic or smeared by tillage implements. Tillage should cause fracturing rather than smearing.

In any given year as much as 80% of the soil surface in a field will be exposed to wheel traffic. If that traffic passes over the soil when it is wet or if the vehicle has a very high contact pressure, soil compaction will occur. Traffic compaction is more serious than tillage compaction as it extends further into the rootzone and is more difficult to reverse.

The following are some prevention measures to avoid compaction problems:

- **STAY OUT OF WET FIELDS!**
- improve drainage;
- increase floatation on all vehicles entering the field;
- avoid following the same path through the field;
- move major tillage operations out of the wet time of the year;
- reduce the number of times vehicles enter the field by altering cropping system;
- adjust tillage practices;
- adjust crop management; and
- reconsider timing of field operations.

11.2: Gas Emissions That Cause Global Warming

Certain gases in our environment act like a greenhouse, trapping the sun's heat, which then heat our atmosphere and cause global warming. This process is known as the greenhouse effect. Carbon dioxide and other gases that contribute to the greenhouse effect are increasing in concentration due to discharges caused by human activities.

The federal government has committed Canada to stabilizing gas emissions that cause the greenhouse effect at 1990 levels by the year 2000. Agriculture helps by absorbing greenhouse gases such as carbon dioxide. Agriculture does contribute to greenhouse gas accumulation by the production of methane, nitrogen oxide and carbon dioxide. Improved treatment, handling and utilization of manure offers the greatest potential for the reduction of methane and nitrogen oxide gases. Agriculture must be aware of the need to reduce greenhouse gas emissions and be willing to do its part.

The provincial government's clean air strategy may involve initiatives for agriculture that are not addressed in these guidelines. At present it is not clear what effect agriculture has on the greenhouse effect. Research on agriculture's emission sources and potential activities for remediation will help to identify agriculture's role.

11.3: Woodwaste Products

Woodwaste products play an important role in the rearing of dairy cattle. The majority of dairy operations use woodwaste products such as sawdust or shavings for bedding. This woodwaste breaks down with the manure to form a soil amendment when applied to cropland.

Woodwastes, when not handled properly, can become a threat to the environment. Leachate from stored woodwaste entering surface or groundwater causes pollution. Leachate is formed when exposed woodwaste has contact with rainwater or surface water. Leachate is identified as the black liquid forming at the base of the woodwaste pile. This black liquid is deadly to fish and degrades water quality.

Some considerations for the use and handling of woodwaste are:

- Woodwaste on farms may only be used for plant mulch, soil conditioning, animal-poultry bedding, ground cover, equestrian facilities, on farm access ways and berms used in cranberry production.
- Sites where woodwastes are used must be located at least 30 m (100 ft) from any source of water used for domestic purposes.
- Woodwaste can not be used for a landfill material without a permit or approval from the BC Ministry of Environment, Lands and Parks.
- Woodwaste products stored on the farm must be stored in such a manner that leachate does not escape to surface or groundwater. Covering stored woodwaste is an effective means of reducing leachate production.
- Woodwaste bedding when removed from the barn must be stored in compliance with Section 8, Manure Storage in these guidelines. Correct storage will not allow leachate to enter surface or groundwater.
- Repeated application of manure, heavily bedded with woodwaste products, onto cropland may result in a shift of the C:N ratio. Changing the C:N ratio could reduce the ability of crops to grow.
- For more information, consult the **Woodwaste Guidelines** listed in Appendix E, Reference Material.

Woodwaste may contain chemicals used for the preservation of wood, for stain prevention or for fire retardation. Chemicals such as penta and tetrachlorophenol can be found in cattle and milk as a result of breathing in, eating or touching chemicals in treated wood. Care must be taken by the dairy operator when chemically treated woodwaste is used on the farm.

11.4: Other Farm Animals

Farm animals other than dairy cattle that are housed on a dairy farm can contribute to environmental problems.

Other farm animals including horses, other cattle, sheep etc., must not

be overlooked. They too need environmentally sound housing and handling structures. The number of other farm animals is usually small. However, where other animals are kept it is adviseable to obtain the applicable environmental guidelines.

Grazing Areas. Other farm animals on pasture should be grazed considering the points discussed in Section 7, Outdoor Areas. There should be few environmental concerns if proper water access is ensured and good management is practiced.

Seasonal Feeding Areas. Other farm animals held on these areas will require a pollution risk evaluation similar to beef cattle. Refer to Section 4.2, Seasonal Feeding Areas in the **Beef Environmental Guidelines** or see Engineering Factsheet **Environmental Evaluation of Beef Cattle Seasonal Feeding Areas (312.160-1)**, listed in the Appendix E, Reference Material.

Confined Livestock Areas. Other farm animals are sometimes held on sites such as exercise yards or corrals. These sites are defined as confined livestock areas. Other farm animals on these areas cannot have direct access to natural watercourses,but must be watered using livestock waterers. Cleaning and spreading of manure and runoff control must be considered as discussed in Section 7, Outdoor Areas.

As mentioned in the Code of Agricultural Practice for Waste Management, on small farms of less than 10 agricultural units, other farm animals can be held in confined livestock areas that are within the recommended 30 m (100 ft) setback from a watercourse. However, since the 10 agricultural units include all livestock on the farm, it is unlikely this provision will apply to dairy operations.

11.5: Handling and Disposal of Pesticides

This section outlines good agricultural environmental practices to be followed when using pesticides. As there are numerous articles readily available outlining personal protection when using pesticides, the aim here is to identify steps directed at protecting the environment. A pesticide applicator course for agricultural producers is available from the BC Ministry of Environment, Lands and Parks. There are a number of restricted pesticides that can only be applied by an applicator who has passed the applicator's course and who has been certified.

Agricultural production guides with reference sections on pesticide use are available from the BC Ministry of Agriculture and Food. For more general information on pesticide application see **The Handbook for Pesticide Applicators and Dispensers** listed in Appendix E,

Reference Material.

TRANSPORTATION

The following items should be considered when transporting pesticides:

- only transport undamaged and labelled pesticide containers that are securely closed;
- secure pesticides during transport;
- transport pesticides on non-absorbent material (e.g., metal or plastic, not wood);
- the total quantity of pesticide product in the vehicle cannot exceed 500 kg (1,100 lbs); and
- sprayers containing a spray mixture in excess of 5,000 litres (1,320 U.S. gal) cannot be driven on a public road.

SAFE USE OF PESTICIDES

Before mixing pesticides:

- identify the pest correctly;
- use only recommended pesticides for the problem;
- read the label and follow the safety precautions;
- ensure application equipment is in good working order and properly calibrated; and
- be prepared to handle a spill, (see in this Section, Pesticide Spills on the Farm for details).

While mixing and applying pesticides:

- observe a 10 m (35 ft) pesticide free zone from all watercourses;
- mix only the pesticide you need for that day;
- always have water available for washing;
- do not exceed the rate specified on the label; and
- have an approved backflow prevention device on the waterline used to fill the sprayers.

DRIFT CONTROL

Drift refers to the movement of pesticide droplets or dust, by wind or air currents, away from the target area. Drifts may be in droplet or vapour form. Droplet drift is related to droplet size. The smaller the droplets, the farther the wind can carry them from the target. Droplet size or the distance from the nozzle to the target influences the amount

of liquid-droplet drift.

Vapour drift from volatile chemicals can continue long after the spraying operation. Small amounts of highly volatile pesticides can injure susceptible plants, as well as impact a watercourse well outside the treated area. This injury often occurs during stable air conditions, which allow the vapours to collect and remain undiluted.

To minimize spray drift, take the following precautions:

- use low spraying pressure to reduce the number of fine spray droplets produced;
- keep boom height as low as possible while maintaining uniform coverage;
- use nozzles that produce drops more resistantto drift, such as low-pressure, flat-fans flooding or raindrop nozzles;
- choose chemicals that do not require high pressure and fine droplets;
- replace or clean faulty nozzles that cause fogging;
- use low volatility chemicals that reduce vapour drift;
- use antidrift additives to increase viscosity at the nozzle orifice so that fewer fine droplets are produced;
- use special, low volume type sprayers; and
- spray when winds are less than 8 km per hr (5 miles per hr). Early morning and evening are often good times, particularly for very volatile chemicals.

DISPOSAL OF PESTICIDE CONTAINERS

Empty pesticide containers can be hazardous to the environment if not disposed of properly. Producers should take the following precautions:

- drain the container into the tank;
- rinse the container, pouring the rinse water into the sprayer tank each time as explained in Table 11.1;
- crush or puncture the container so that it cannot be reused;
- deliver the container to a sanitary landfill or store in a safe place for a short time until delivery can be made; and
- clean sprayers or empty containers as far from a watercourse, ditch, or well as required to eliminate the possibility of pesticides being washed back into the surface or ground water.

PESTICIDE STORAGE

Pesticides should be stored in a dry, well ventilated building that can be locked. The storage must be located away from watercourses and from wells to avoid contamination in the event of a spill or a fire. It is a good idea when storing liquid pesticides to provide a sump made of concrete or other impervious material that will contain a spill and allows for subsequent washing.

Further considerations are as follows:

- separate the storage facility from working and living areas;
- follow label directions for storage;
- place a warning sign on entrances;
- tightly close containers;
- do not store pesticides with food, feed, fertilizer or seed;
- use the storage facility for any pesticides that are not currently in use;
- do not store personal protective equipment in the storage facility. Keep it nearby in case of an accident;
- store herbicides away from other pesticides;
- keep absorbent materials like clay, kitty litter, sawdust, etc., handy in case of a spill; and
- keep an updated list of stored pesticides and inform the local fire department of the contents and location of the pesticide storage facility.

DISPOSAL OF UNWANTED PESTICIDES

Disposal of unwanted pesticides is a critical problem and has no simple solution. The best precaution against pesticide disposal is good planning.

Only purchase quantities of pesticides that you should be able to use up within two years. Prepare the exact amount of spray mixture that you need.

Accurate knowledge of field size and sprayer output will help avoid mixing excess spray material. If you end up with surplus mixture, avoid reapplying it to your crop as it may result in high pesticide residue levels. Instead, you could spray the headlands but be aware that high herbicide residues could affect future crops. Do not apply pesticides next to ditches, watercourses or wells. When there is a need to dispose of excess spray mixture, use a carefully selected waste area. The waste area should be away from people, crops, watercourses, sewers and ditches and should not be on land subject to flooding. The soil at the waste area should be fine (e.g., clay) rather than coarse

(e.g., sand) to prevent leaching into groundwater. Do not dump spray mixtures where you may dig a well, put up a building, or plant a crop in the future.

Sometimes you may no longer need certain pesticides. Unwanted pesticides should be disposed of properly, not stored. If you have unwanted pesticides and need information, advice or assistance regarding disposal, contact the nearest office of BC Ministry of Environment, Lands and Parks.

PESTICIDE SPILLS ON THE FARM

Occasionally pesticide spills occur. If this happens immediately contact the BC Ministry of Environment, Lands and Parks and the local Medical Health Officer and explain the circumstances surrounding the spill. The following are a few guidelines for cleaning and decontaminating the area:

- Prevent people and animals from being exposed to the pesticide and its fumes.
- For your own safety, tell someone that you are cleaning up a pesticide spill, where you will be and when you are expected to return.
- Put on protective equipment before cleaning up the spill. Rubber boots and gloves are necessary. Overalls, respirators and eye protection should be worn for toxic pesticides. Remember that you are handling concentrated pesticides.
- Prevent the spread of the pesticide. Cover a liquid pesticide with soil, sawdust or any absorptive material.
- Ventilate the area.
- Once the liquid is absorbed into the material, remove the contaminated material to a safe place. Bury the contaminated material at least 50 cm (20 in) deep in an area that will not be cropped and is a minimum of 30 m (100 ft) from a watercourse. Also, avoid areas that can leach to groundwater or are subject to flooding.
- Decontaminate the surface. Check the label for specific directions. Many pesticides can be detoxified by washing the area with chlorine bleach and detergent. Take care to prevent the wash solution from spreading and contaminating a larger area.

If the spill occurs outside on the ground, cover with soil and allow the pesticide to soak into the ground. DO NOT use this as a method of disposing of excess amounts of pesticides. If the spill occurs beside a watercourse, remove the top layer of contaminated soil and bury it as

described in this section called Disposal of Unwanted Pesticides.

Contamination caused by chemical spills that occur during sprayer filling are a major concern. It is recommended that a plan be in place to prevent this occurrence. A plan should provide for:

- a berm around the well that will deflect surface spills away;
- a sprayer filling location sited at a lower elevation than the well;
- a location for sprayer filling sited 10 m (35 ft) away from well; and
- standby equipment including absorptive material, shovel, etc., that is readily available.

11.6: Chemigation

Chemigation is the practice of injecting chemicals into an irrigation system for application to a crop or field. Chemicals that are injected include fertilizers, herbicides, insecticides, fungicides, nematocides and growth regulators. The practice of chemigation is rapidly expanding due to the many advantages that are offered to producers. In some instances there is a potential for reducing the amount of chemical applied.

Chemigation does, however, present a risk. Potential contamination of the water source due to backsiphonage and backpressure is possible if an unexpected shutdown of the irrigation system should occur while injection is taking place. This risk can be minimized if proper backflow prevention devices are installed and proper chemigation procedures are followed.

A BCMAF publication **Chemigation Guidelines for BC** is available. This publication is listed in Appendix E, Reference Material. The intent of this publication is to inform producers of the laws, regulations and standards that currently exist in British Columbia. The publication provides information on irrigation system design and operation of chemigation systems, guidance on the selection of chemicals for injection and outlines methods of calculating chemical injection rates.

Current laws and regulations are in place for some water suppliers. Unfortunately, backflow prevention standards differ between districts and municipalities. Producers obtaining water from streams or other natural sources are not under the authority of a watersupplier. In these instances standards are not usually enforced. The chemigation manual should be used by agricultural producers as a chemigation standard in instances where a higher authority has not established a standard.

The most common use of chemigation by dairy producers is likely to be application of fertilizers to forage crop through an irrigation system. The term fertigation is used to describe this particular form of chemigation.

11.7: Farm Medical Wastes

The use of medication in livestock production is a common practice. There is a growing volume of spent medicines, empty containers and other medical items that must be disposed of in an acceptable manner.

For most dairy producers, incineration of farm medical waste in an **approved** facility (an incinerator designed to consume medical waste) is not possible. Those producers should consider the following:

- farm medical waste that has the potential to puncture or cut should be packaged in a rigid container (plastic) and discarded with household waste;
- disinfect needles, syringes and other items prior to discarding by boiling for five minutes or soaking in disinfectant;
- needles should be Åground-offÅ or otherwise destroyed to eliminate the chance of puncturing a trash handler;
- medical supplies that have outlived their shelf life should be taken back to the suppliers; and
- the BC Ministry of Environment, Lands and Parks be contacted if quantities destined for disposal are in excess of 5 kg (10 lb) or 5 litres (1 gal).

11.8: Petroleum Products

On farm receiving and dispensing sites for gasoline and diesel fuels are potential sources of pollution. Fuel spills and disposal of used oils can be a major threat to soil and water quality. It takes very little product to have a detrimental effect on the receiving environment.

When handling, storing or disposing of petroleum products consider the following:

- fuel tanks must be equipped with an anti-siphoning device included in the tank discharge unless a self-closing nozzle is provided;
- drains must be lockable in the closed position;
- storage tanks must be constructed in accordance with accepted engineering practice, and may include a concrete, dyked facility;
- tanks must be located away from yard drains;

- tanks should be set back 10 m (35 ft) from a watercourse or ditch;
- care must be taken when filling the tank to ensure no overflow occurs;
- care must be taken when dispensing fuels to ensure no overflow occurs; and
- the tank should be protected from direct collision by farm vehicles.

For disposal of spent or used oils, the best alternative is to return the oil to an approved recycling centre for recycling. Used oil when applied to roads as a dust suppressant is a threat to the environment and receiving waters.

11.9: Plastics

Plastics are used in many areas on dairy operations. A considerable amount of plastic is used in feed storage, as hay and silage covers, or in bagging chopped and round baled silage. It is also commonly used for hay twine, buckets, etc. Farm plastics should be disposed of, reused or recycled. Only plastics that have contacted or contained toxic materials such as pesticides, need to be disposed of as outlined in Section 11.5, Disposal of Pesticide Containers.

The best method of handling plastics is by recycling. Some distributors of plastics are currently considering recycling systems to reduce the environmental concerns of their clients. Until recycling is available, plastic sheeting, bags, twine and other farm plastics should be cleaned up and disposed of at an approved municipal land fill site.

11.10: Burning

Material being burnt should be restricted to straw, hay, untreated wood and brush. Plastics, tires and garbage should not be burned. Producers should consult Environment Canada's Ventilation Index before burning to verify atmospheric conditions are suitable for adequate dispersal of smoke and particulate. The Ventilation Index is available from the regional offices of the BC Ministry of Environment, Lands and Parks, Environmental Protection staff.

The BC Ministry of Environment, Lands and Parks does not require a permit for burning of crops or stubble. A permit is required when burning for land clearing or tillage reasons if:

- the volume of material to be burned exceeds 10 m3/ha per month (140 ft3/ac per month); or

- the duration of the burn is more than 24 hours.

The BC Ministry of Forests requires a burning permit for land clearing, machine piles, logging debris and broadcast burning. Producers should contact both Ministries before conducting any burning.

11.11: Gyproc Paper

Paper stripped from gryproc and shredded for use as an inexpensive bedding material has been used with some success by dairy producers. There are, however, some concerns brought forward that are worthy of note:

- There may be nails in the product.
- There may be significant amounts of gypsum still stuck to the paper.
- There may be a gas build-up in the manure after six months use, that causes a very strong odour.
- Crusts do not form on manure in storage.
- Gypsum is not a substitute for agricultural lime as a liming material.

TABLE 11.1 Methods For Rinsing Empty Pest Control Product Containers (a)

Type of Container	Rinsing Methods(b)
Rigid plastic or metal (nonpressurized)	Pressure rinse, or single rinse 3 times
Rigid plastic or metal (pressurized)	No rinsing required
Glass bottle	Rinse 3 times
Paper bag	Rinse
Plastic bag	Rinse
Containers labelled "domestic"	No rinsing required
Any container type not listed above	As approved

A waste pest control product container that has been emptied and rinsed shall be disposed of:
(a) in an approved landfill, or;
(b) by burying it, but only if;
(i) the burial location is owned or leased by the person owning the

container;

(ii) the burial location is on flat ground, not in a swale at least 200 m (660 ft) from surface water or a well;

(iii) the ground does not consist of gravel, sand or other similarly porous material, and;

(iv) the owner covers it with at least 0.5 m, (20 in) of soil immediately after burial.

(a) Excerpt from the Special Waste Regulation of Waste Management Act.

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Environmental Guidelines for Dairy Producers

A: BCMAF Environmental Programs

The British Columbia Ministry of Agriculture and Food (BCMAF) has four non-regulatory environmental programs. The four programs outlined below are: Best Agricultural Waste Management Plans, Best Soil Management Plans, Nitrogen Behaviour Simulation Model, and ALDA.

A.1: Best Agricultural Waste Management Plans

Best Agricultural Waste Management Plans provide waste management suggestions to dairy producers who have pollution concerns caused by:

- livestock manure (collection, storage or spreading);
- milkhouse wastes;
- dead animals (disposal);
- livestock feed; or
- yard runoff (clean water running into livestock yards, or manure running out of yards).

Best Agricultural Waste Management Plans are not intended to address pesticide pollution concerns.

Producers who want a Best Agricultural Waste Management Plan prepared for their farm should contact their local agricultural office (see inside back cover for office closest to you). The District Agriculturist will discuss the need for the Plan with you. The request for a Plan is then sent to the Soils and Engineering Branch. An engineering specialist will visit the farm with the producer. Jointly they will develop the Best Agricultural Waste Management Plan to address the pollution concerns.

The Plan will consist of a written description of the present situation,

possible pollution problems, suggestions for improvement. Sketches are included if appropriate. The suggestions are grouped into three areas: (A) very important, (B) important, and (C) should be considered. The plan will also indicate works that require a professional engineering design.

When all the concerns in the Best Agricultural Waste Management Plan are addressed, the dairy producer's operation should be in compliance with all provincial and federal environmental laws and regulations.

A.2: Best Soil Management Plans

Best Soil Management Plans are intended to provide soil management recommendations for farms that have problems with:

- soil erosion;
- soil compaction;
- organic soil subsidence;
- soil structure deterioration;
- soil moisture deficit (where irrigation is not available); or
- soil acidity.

Best Soil Management Plans are not intended to address routine soil management concerns, such as soil fertility.

Soil management recommendations identified in the Best Soil Management Plans may require professional expertise to implement.

Those producers wishing to take part in the program should follow the same procedures used to obtain a Best Agricultural Waste Management Plan.

A.3: Nitrogen Behaviour Simulation Computer Model

The model simulates nitrogen behaviour from the time that it leaves the animal as manure until it enters the soil and is eventually taken up by a crop, lost to the environment, or becomes a component of soil organic matter. The model consists of four parts: manure transformations during collection, storage and spreading; soil processes; crop growth; and water movement through the soil.

Four categories of input information are required from the user: manure type and characteristics, soil type, climatic parameters and crop type. This information is used by the model to predict the crop yield, crop nitrogen uptake, organic nitrogen mineralization, and

nitrogen losses due to volatilization, leaching and denitrification.

The model can be used to assess manure management practices to determine effect on crop production. The model also will predict the potential for environmental contamination.

Producers wishing to assess their situation using this model should contact the Soils and Engineering Branch.

A.4: The ALDA Program

The ALDA Program (Agricultural Land Development Assistance Program) provides low interest loans for on-farm capital improvements. Agricultural credit is available for a minimum project cost of $5,000. The maximum loan per farm operation is $75,000. Loans are for a 15 year term and interest rates are at half of the bank prime rate on approved credit.

Application to the ALDA Program is made by contacting the District Agriculturist or District Horticulturist at your local BCMAF office (see list inside back cover).

A sustainable agriculture industry depends on the effective use of farming practices that maintain and enhance soil and water quality. However, those practices must be cost-effective. Often, implementing sustainable farming practices are expensive, and in these cases the ALDA Program is there to help.

There are many items that qualify for ALDA assistance. For example, manure storage facilities qualify. The ALDA program has been expanded to include loans for environmental initiatives. Under the Environmental Initiatives Section, a producer can obtain financial assistance for the capital items that have been identified as qualifying in a Best Agricultural Waste Management Plan or Best Soil Management Plan. Part of the capital costs of these items includes the costs of a professional engineer or agrologist where used.

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Environmental Guidelines for Dairy Producers

B: BC Federation of Agriculture

B.1: Agricultural Environmental Protection Council

Farm leadership is essential in dealing with soil, water and air environmental concerns. The adoption of environmentally sustainable production practices is an aim of the BC Federation of Agriculture. Research scientists, farm advisors, agribusiness environmental experts and others are required to provide farmers with information, guidance and assistance. However, the change to environmentally sustainable agriculture can only be implemented by individual farmers on their own farms. In 1990, the BC Federation of Agriculture formed the Agricultural Environmental Protection Council. The purpose of the Council is to resolve nuisance and pollution complaints against farms and ranches in BC. This is done by peer producers explaining the concerns and helping to find a solution to an individual producer's environmental problem. Education is the preferred first step before regulatory agencies force farmers to adopt corrective measures.

The Agricultural Environmental Protection Council (AEPC) has grown out of the Agricultural Environmental Service (AES) Program. The AES had its beginnings as the Poultry Sanitation Committee that was formed in the 1960s. The AES program grew to handle complaints regarding nuisance of improper waste handling on beef, dairy, hog and poultry farms. Where the AES primarily handled nuisance complaints from the public, the AEPC responds to both pollution and nuisance concerns. Concerns can come from both the public and government agencies. All member commodity groups of the BC Federation of Agriculture are invited to take part in the program. Therefore, the AEPC will cover a broader cross section of agriculture.

The aim of the AEPC is to set and maintain high environmental standards for participating commodities. To do this the AEPC has developed and is monitoring a program that responds to and resolves nuisance and pollution complaints against farms and ranches in BC.

The AEPC has representation from the BC Federation of Agriculture; participating agricultural commodity groups; BC Ministry of Environment, Lands and Parks; and BC Ministry of Agriculture and Food. Agricultural commodity groups volunteer to participate in the AEPC and its peer inspection program.

Upon receipt of a complaint, the AEPC will initiate the following process:

1. Contact will be made with the local peer inspector/advisor and the complaint will be investigated within two weeks of receipt of the complaint.
2. The local peer inspector/advisor will write an inspection report explaining what the environmental concern is and if it is justified. The report will also explain what corrective measures are required, and a date by which the corrective measures should be installed and operating. This inspection report is sent within two weeks of the inspection to the farm complained against, as well as to the person complaining, and to the AEPC.
3. The local peer inspector/advisor will be con-tacted to do a follow up visit to the farm complained against. This follow up visit is to occur on or about the date that the corrective measures should have been installed. Normally, this would be not more than six months after receiving the complaint.
4. The local peer inspector/advisor will write a compliance report explaining if the corrective measures were all installed as outlined in the inspection report (see 2 above). If all the corrective measures are not installed the inspectors should try to find out why. This compliance report is sent within two weeks of the follow up visit to the farm complained against, to the person complaining, and to the AEPC.

5. Farmers who are still causing an environmental problem after going through steps 1 to 4 will be referred to the appropriate government agency.

Farms that are farming in an environmentally sound manner or those that, after inspection, change to anenvironmentally acceptable method should not have to deal with the regulatory agencies. Only those farmers who choose to remain farming in an environmentally unacceptable manner will be under the influence of the regulatory agencies.

This process also allows the AEPC to review all inspection and compliance reports. AEPC can make sure all farms are treated fairly, and that inspector /advisors are making reasonable suggestions.

As there is a need to respond to complaints promptly, there are inspectors/advisors for each commodity throughout the province.

Inspector/advisors in each of the commodities receive training, making them aware of the requirements and standards set out by the AEPC. Training includes methods of reporting, how to get technical assistance to the farm, and when to involve a regulatory agency.

The Environmental Guidelines for Dairy Producers in British Columbia is the standard used by the dairy peer inspector/advisors to determine compliance with the Code of Agricultural Practice for Waste Management.

The AEPC will review this process on a regular basis to ensure that high agricultural waste man-agement standards and environmentally responsible agricultural waste management practices are maintained on British Columbia's farms and ranches.

B.2: AEPC Relationship to Regulatory Agencies

The Agricultural Environmental Protection Council will, in most cases, be the initial mechanism for resolving agricultural environmental complaints. See Table B.1 (in this Appendix) for ways that the complaint could travel to the AEPC Program.

There is nothing written to suggest that the AEPC must receive the first opportunity to solve the complaint. Provided that AEPC can make sound resolutions and recommendations that result in addressing the complaint fully on the first inspection, the first opportunity to resolve the complaint should be with the AEPC. It must be pointed out that the BC Ministry of Environment, Lands and Parks has the right to take action at any time pollution occurs, or if producers do not meet the Code of AgriculturalPractice for Waste Management. Dairy producers are well advised to clean up existing waste problems before they become an issue.

Table B.1 summarizes how the various agencies that are involved interrelate when addressing environ-mental concerns. Table B.1 also contains a column showing the agency that will become involved when there is non-compliance with AEPC suggestion or if the suggestion do not solve the complaint.

The legislative authority for enforcing provincial environmental standards is the BCMELP under the Waste Management Act, the Agricultural Waste Control Regulation and the Code of Agricultural Practice for Waste Management.

B.3: Land Management Assistance Program

The Land Management Assistance Program (LMAP) is designed to encourage producers to adopt effective, environmentally sustainable agricultural practices. LMAP is a land use program that will provide financial assistance for on-farm soil and related water conservation projects, and land resource use adjustments.

Eligible activity must address one or more of the following: conservation or preservation of soil resources, enhancement of surface water quality, enhancement of ground water quality, pollution abatement, or waste management. Ineligible activities include, but are not restricted to: aquaculture, routine farm irrigation, routine farm drainage associated with improvement of soil conditions, land clearing, and manure storage. Also excluded are purchases of equipment or machinery routinely used by operations in your commodity. Projects must comply with federal and provincial environmental regulations and guidelines as well as producer codes of practice.

Approved projects will receive reimbursement of up to 50 per cent of eligible expenditures, up to a maximum of $5,000 per individual farming operation.

LMAP is administered by ARDCORP, a subsidiary of the BC Federation of Agriculture. Application forms are available from ARDCORP, phone 383-7924, fax 383-5031 or write to ARDCORP c/o BC Federation of Agriculture.

TABLE B.1

Guideline To The Interrelationship Of The Federation AEPC Program and Government Agencies

Type of Environmental Concern	Severity of Issue	Who to Contact	Inspection and Recommendations	Reinspection for Compliance	Final Action for Noncompliance
Pollution of Air or Water	severe	MOE	MOE/AEPC	MOE	MOE
	nonsevere	MOE	AEPC	AEPC	MOE
Pollution of Fish Habitat - Provincial	severe	MOE	MOE/AEPC	MOE	MOE
	nonsevere	MOE	AEPC	AEPC	MOE
Pollution of Fish Habitat - Federal	severe	DFO	DFO/AEPC	DFO	DFO
	nonsevere	DFO	AEPC	AEPC	DFO
Human/Public Health Implications	severe	MOH	MOH/AEPC	MOH	MOH/MOE
	nonsevere	MOH	AEPC	AEPC	MOH/MOE
Nuisance		AEPC	AEPC	AEPC	Local Government
Environmental Audit		MAF	MAF/BAWMP Consultant		

Legend

AEPC Agricultural Environmental Protection Council (BC Federation of Agriculture)
BAWMP Best Agricultural Waste Management Plan (BCMAF)
DFO Department of Fisheries and Oceans
MAF BC Ministry of Agriculture and Food
MELP BC Ministry of Environment, Lands and Parks
MOH BC Ministry of Health

NOTE: An environmental concern may be of interest to more than one agency.

The AEPC can be reached by contacting the BC Federation of Agriculture. Complaints can be registered with the BC Federation of Agriculture.

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Environmental Guidelines for Dairy Producers

C: Agricultural Waste Control Regulation and Code of Agricultural Practice For Waste Management

The Code of Agricultural Practice for Waste Management is part of the Agricultural Waste Control Regulation, which is part of the Waste Management Act administered by the BC Ministry of Environment, Lands and Parks. The Code of Agricultural Practice for Waste Management was drafted by the Ministry of Environment, Land and Parks; Ministry of Agriculture and Food; Ministry of Health; Federation of Agriculture; the Federal Department of Fisheries and Oceans; and with local government representation.

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D: Dairy Cattle Manure Land Application

D.1: Detailed Calculations

Acceptable minimum area required for manure spreading can be calculated using the following formula:

Land Requirements (Hectares) =

$$\frac{\text{1.4 x Total Animal Places x Manure N Factor}}{\text{Crop N Removal x Adjust. Factor x Crop Yield}}$$

- **Animal Place:** Found in Table D.3
- **Manure N Factor:** (see D.2 Assumption) 74 kg N per animal place per yr.
- **Adjust. Factors:** Found in Table D.2
- **Crop N Removal:** Found in Table D.1
- **Crop Yield:** Should be the normal yield per hectare (see Table D.4 Typical Crop Yields)

More detailed information on manure application rates to crop land is available in the **Manure Management Guidelines** listed in Appendix E, Reference Material.

D.2: Assumptions

CONFINED LIVESTOCK MANURE

Nitrogen in Manure. A milking cow place excretes 116 kg nitrogen each year. A dry cow place excretes 58 kg nitrogen each year. A heifer place excretes 46.4 kg nitrogen each year. A calf place excretes 16.8 kg nitrogen each year.

Losses During Storage. When spread to land, dairy manure will contain 77% of excreted nitrogen.

Nitrogen Losses During Spreading. For manure incorporated into the soil within 24 hours, 83% of the applied manure nitrogen is incorporated into the soil. Therefore, one animal place will supply the soil with (116 kg x 0.77 x 0.83) = 74.1 kg N/yr.

Manure Application to Grassland. Although sod injection of manure has been used with mixed success elsewhere, it is highly unlikely that it will become a common practice in BC in the near term. Therefore, the assumption is made that

manure application to grassland is not incorporated (although it is recognized that irrigation following manure application can substantially reduce nitrogen losses). Because of higher nitrogen losses from unincorporated manure, the values in Table 9.3 for grass have been increased by 1.25. Grassland means grassland that is cropped with no livestock grazing that grass. Where grazing occurs, adjustment in the volume of wastes is required as the grazing stock add wastes over the time that they are in the field.

Nitrogen Supply from the Soil. Table 9.3 assumes crops are being produced on soils containing more than 10% organic matter. If soils contain 5 to 10% organic matter, rate of application can be increased by a factor of 1.2, and if less than 5% organic matter, rates can be increased by 1.4.

Nitrogen Removal. Nitrogen removal values in Table 9.3 are based on the nitrogen content of high yields for various crops. These values assume the most common practices are followed concerning the removal from the land of the non-harvested portion of the crops. For example, it is assumed that 100% of the above ground portion of a silage corn crop is removed. On the other hand, for broccoli, it is assumed that the non-harvested, above ground portion of the crop is left in the field and eventually incorporated into the soil. The nitrogen in non-harvested portions of crops is assumed to contribute to the soil's supply of nitrogen for subsequent crops. Approximately 50% of the nitrogen in the refuse portion is assumed to be available to subsequent crops.

Routine Use of Manure. When manure is applied regularly for a number of years, nitrogen in the organic portion of the manure is released over time to subsequent crops. The values in Table 9.3 assume routine, annual use of manure (20% of the nitrogen supply is assumed to come from previous manure applications). If, however, manure is used infrequent (one or two applications over a five or more year period), the rate can be increased without undo environmental hazard (the adjustment factor is chosen is 1.5).

Table 9.3 on page 44 was developed using average crop yields and protein levels shown in Table D.1.

Note: These manure application rates supply only 75% of the recommended fertilizer nitrogen. The remaining nitrogen should be supplied by inorganic fertilizer.

IRRIGATED PASTURE AND CONTROLLED GRAZING

Nitrogen in Manure. Seventy percent of the nitrogen an animal ingests it excretes in urine and feces. Manure deposited on the ground loses 50% of the nitrogen to the atmosphere by volatilization.

Nitrogen in Forage. Forage grasses contain 2% nitrogen at time of ingestion.

TABLE D.1

Nitrogen Removal Per Harvested Tonne Of Various Crops

Crop	Protein levels %	kg N Removal per Tonne of Crop Removed
Cereals - grain only	12.5	20.0

Cereals - whole crop	10.0	16.0
Grass	12.0	24(a) (per tonne dry matter)
50% Grass - 50% Legume	12.0	12(a) (per tonne dry matter)
Silage Corn	8.0	12.8 (per tonne dry matter)
Broccoli		10.0
Brussels Sprouts		10.0
Cabbage		3.7
Carrots		3.0
Cauliflower		6.3
Lettuce		2.5
Onions		2.7
Potatoes		4.6
Raspberries		7.7
Sweet Corn		8.0

To convert to Imperial unit: 1 kg N/tonne = 2.0 lb/ton

(a) N removal has been increased by 25% to account for increased volatilization losses of nitrogen.

TABLE D.2

Adjustment Factors To Be Used With TABLE D.1

1. Soil organic matter	less than 5% 5 to 10% more than 10%	1.4 1.2 1.4
2. Application frequency	frequent one time or infrequent (less than once every two years)	1.0 1.5
3. Protein levels in forage crops	Ratio of actual levels to levels in TABLE D.1	= 16 = 1.3 ---- 12

TABLE D.3

Animal Place Equivalents

One Animal Place Equals:	1 Milking Cow or 2 Dry Cows or 2.5 Heifers or 6.9 Calves

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TABLE D.4

Typical Crop Yield And Protein Levels (a)

Crop	South Coastal		Kootenays		Okanagan Thompson		Central BC		Peace River(b)	
	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %	Yield t/ha	Protein %
Cereals -Grain only(c)	4-7	10-14	--	--	2-6	11-16	--	--	1	10-14
Cereals -whole crop 1 cut(c)	2-4(d)	12-15	5-9	8-11	6-13	10-12	3-7	7-12	2-9	7-10
Cereals -whole crop 2cut(c)	--	--	--	--	13-18	6-12	--	--	--	--
Grass(c)	11-13	15-18	4-11	8-18	9-13	8-19	2-5	8-12	--	--
50% Grass -50% Legume(c)	--	--	6-13	8-18	9-18	8-16	8-12	8-16	2-8	8-16
Silage Corn(c)	15-20	8	--	--	12-16	7-8	8-13	7-8	--	--
Broccoli	9-13	--	--	--	--	--	--	--	--	--
Brussels Sprouts	9-13	--	--	--	--	--	--	--	--	--
Cabbage	18-31	--	--	--	--	--	--	--	--	--
Carrots	34-56	--	--	--	40	--	--	--	--	--
Cauliflower	11-18	--	--	--	--	--	--	--	--	--
Lettuce	34-45	--	--	--	--	--	--	--	--	--
Onions	34-56	--	--	--	--	--	--	--	--	--
Potatoes	15-45	--	22-45	--	22-45	--	--	--	--	--
Raspberries	7-13	--	--	--	2-9	--	--	--	--	--
Sweet Corn	13-20	--	--	--	10	--	--	--	--	--

To convert to Imperial Units 1 tonne/hectare = 0.45 ton/acre

(a) Water for the crop is not limiting (i.e., this is not for dry land farming) (b) Average crop yields are for dryland conditions (c) Yield is dry matter yields (d) Grown as a cover crop (cereals are harvested immature)

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Environmental Guidelines for Dairy Producers

E: Reference Material

Publications and where they are available from :

1. **Agricultural Composting Handbook**/BC Ministry of Agriculture and Food.
2. **BC Livestock Watering Manual**/BC Ministry of Agriculture and Food.
3. **BC Sprinkler Irrigation Design Manual**/ BC Ministry of Agriculture and Food.
4. **Dairy Cattle Structures Handbook**/BC Ministry of Agriculture and Food.
5. **Canadian Farm Building Code**/The Secretary, Associate Committee on the National Building Code, National Research Council, Ottawa, Ontario, Canada, K1A 0R6.
6. **Canadian Farm Building Handbook**/ Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada, K1A 0S9.
7. **Chemigation Guidelines for BC**/BC Ministry of Agriculture and Food.
8. **Environmental Guidelines for Beef Producers in British Columbia**/BC Ministry of Agriculture and Food.
9. **Handbook for Pesticide Applicators and Dispensers**/BC Ministry of Environment, Lands and Parks.
10. **Manure Management Guidelines**/BC Ministry of Agriculture and Food.
11. **Planning Grain-Feed Handling (MWPS-13)** ISBN 0-89373-007-6/Iowa State University, Ames, Iowa, U.S.A. 50011.
12. **Soil Management Handbooks For the Lower Fraser Valley**/BC Ministry of Agriculture and Food.
13. **Soil Management Handbook For the Okanagan and Similkameen Valleys**/BC Ministry of Agriculture and Food.

14. **Ventilation Handbook**/BC Ministry of Agriculture and Food.
15. **Woodwaste Guidelines**/Department of Fisheries and Oceans, Environment Canada.
16. **BC Ministry of Agriculture and Food, Soils and Engineering Branch, Publication List. Examples of interest for dairy producers with environmental concerns:**

200.308-1 Beware of On-Farm Manure Storage Hazards
200.310-1 Pesticide Safety for Field Workers
234.005-1 Suggestions for Field Sprayer Operation and Maintenance
312.100-1 Environmental Evaluation of Beef Cattle Seasonal Feeding Areas
307.000-1 BC Agricultural Fencing Manual
380.750-1 Manure Gases
383.350-1 Gravity Flow Slurry Channels for Dairy Manure
383.510-1 Circulatory Agitation Systems for Dairy Manure Storage Tanks
384.200-2 Rodent & Bird Control in Farm Buildings
384.200-4 Rodent Control on Agricultural Land in BC
386.000-1 Why Keep Livestock Out of Watercourses?
502.000-5 Canada's Fish Habitat Law
502.000-6 Stream Care
590.001-1 Safe and Efficient Nitrogen Use
641.270-1 Ground Stabilization Using Geogrids Improving Cattle Access to Water
650.000-1 Land Application of Animal Manure
652.200-3 Liquid Manure (Slurry) vs Solid Manure in Crop Production

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Environmental Guidelines for Dairy Producers

F: Glossary of Terms

Agriculture Protection Act: BC Act to provide protection to farmers and ranchers that are operated using "generally accepted farming practices" that do not result in pollution.

Areas: Grazing, Seasonal Feeding and Confined Livestock areas are defined in Chapter Seven.

BOD: The measurement of the dissolved oxygen used by micro-organisms in the biochemical oxidation of organic matter.

Clay: (1) A soil type characterized by a very low infiltration rate. (2) A soil consisting of particles less than 0.002 mm in equivalent diameter. (3) A soil class having material containing more than 40% clay, less than 45% sand and less than 40% silt.

Code of Agricultural Practice for Waste Management: Attached to the Regulations of the Waste Management Act to outline environmentally sound agricultural waste practices (see Appendix C).

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, or to an oxide of nitrogen.

Eutrophication: Accelerated aging of a lake or river. It is associated with a high concentration of plant nutrients entering a body of water.

Grass Tetany: Cattle illness caused by eating grass deficient in magnesium. Soils high in potassium can produce grass deficient in magnesium.

Groundwater: Water that fills all the unblocked pores of underlying material below the water table.

Impervious: Resistant to penetration by liquid. Soil with an infiltration rate less then 10-9 m/sec is considered impervious (typically soil with 15% or higher content of clay).

Infiltration: The downward entry of water into the soil.

Loam: The soil class for soil having a moderate amount of sand, silt and clay. Loam soils contain 7% to 27% clay, 28% to 50% silt and less than 52% sand.

Mineralization: The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.

Perennial: A plant that has a life span of three years or more.

Pesticides: Any kind of material used to kill, control or manage pests. Includes insecticides, herbicides, fungicides, miticides etc.

Pollution: The presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment.

Precipitation: The total amount of moisture (rain and water equivalent snow fall) that falls on an area in a given period as determined by the Canadian Atmospheric Environmental Service Reports of Environment Canada. Low precipitation is 600mm (24 in) or less annually; High precipitation is over 600mm (24 in) annually.

Riparian Zone: The narrow strip of land containing moist soils and plants that borders creek, rivers or other bodies of water.

Rendering: To process a cattle carcass for its secondary value, i.e., pet food, etc.

Sand: A soil particle between 0.05 and 2.0 mm in diameter.

Slope (percentage): The incline of a surface given in the number of units of change per 100 units of distance, i.e., a 4% field slope is one that slopes at 4 m per 100 m (4 ft per 100 feet).

Volatilization: The process of chemicals going from the liquid state to the gaseous state.

Waste Management Act: BC Act regulating waste disposal.

Watercourse: A watercourse continuously or intermittently containing water, including a lake, river, creek, spring, ravine, swamp, salt water marsh, bog, and drainage ditch leading into any of the foregoing.

Watertable: The level below which the soil is saturated with water.

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